Civil Action No. 6:21-cv-206

EXHIBIT B

SIEMENS
Ingenuity for life

SDV-R

SDV-R-AR

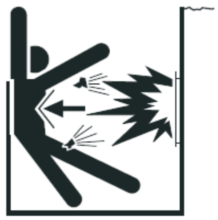
SIDS-T40038-00-4AUS

SDV-R™ and SDV-R-AR™

non-arc-resistant and arc-resistant distribution circuit breakers instruction manual

Installation operation maintenance

usa.siemens.com/sdv



⚠ DANGER

Arc flash and explosion hazard.

Will cause death, serious injury or property damage.

No equipment can completely eliminate the risk of arc flash.

This equipment is not arc-resistant unless all of the following conditions are met:

1. All pressure relief devices are free to operate as designed.
2. The fault energy available to the equipment does not exceed the internal arcing short-circuit current rating and rated arcing duration of the equipment.
3. There are no obstructions around the equipment that could direct the arcing exhaust products into an area intended to be protected.
4. The equipment is installed in accordance with the information in the instruction manuals and drawings.

Important

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligation. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

Qualified person

For the purpose of this instruction manual a **qualified person** is one who has demonstrated skills and knowledge related to the installation, construction and operation of the equipment and the hazards involved. In addition, this person has the following qualifications:

- **Is trained and authorized** to de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
- **Is trained** in the proper care and use of protective equipment, such as: rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
- **Is trained** in rendering first aid.

Further, a qualified person shall also be familiar with the proper use of special precautionary techniques, personal protective equipment, insulation and shielding materials, and insulated tools and test equipment. Such persons are permitted to work within limited approach of exposed live parts operative at 50 volts or more, and shall, at a minimum, be additionally trained in all of the following:

- The skills and techniques necessary to distinguish exposed energized parts from other parts of electric equipment
- The skills and techniques necessary to determine the nominal voltage of exposed live parts
- The approach distances specified in NFPA 70E® and the corresponding voltages to which the qualified person will be exposed
- The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.

⚠ DANGER

Hazardous voltages and high-speed moving parts.

Will cause death, serious injury or property damage.

Always de-energize and ground the equipment before maintenance. Read and understand this instruction manual before using equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause death, severe injury or equipment damage. Follow all safety instructions contained herein.

Note:
These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise that are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Industry, Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Industry, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

Table of contents:

Introduction

⚠ DANGER

Arc flash hazard and hazardous voltages.

Will cause death, serious injury or property damage.

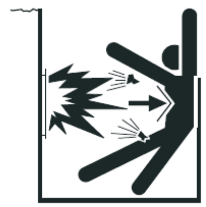
Always de-energize and ground the equipment before maintenance. Read and understand this instruction manual before using equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause death, severe injury or equipment damage. Follow all safety instructions contained herein.

⚠ DANGER

Arc flash hazard, hazardous voltages and high-speed moving parts.

Will cause death, serious injury or property damage.

To avoid arc flash burns, electrical shock and entanglement in moving parts, only qualified personnel should work on or around this equipment after becoming thoroughly familiar with all danger or warning notices, and procedures contained herein. Personnel must observe all applicable regulations (e.g., OSHA), follow all requirements of NFPA 70E and adhere to specific operating procedures applicable to the installation. Use appropriate personal protective equipment (PPE) for the voltage and arc flash incident energy exposure.



⚠ DANGER

Arc flash hazard and explosion hazard.

Will cause death, serious injury or property damage.

No equipment can completely eleminate the risk of arc flash.

SDV-R-AR equipment is not arc-resistant unless all of the following conditions are met:

1. All pressure relief devices are free to operate as designed.
2. The fault energy available to the equipment does not exceed the internal arcing short-circuit current rating and rated arcing duration of the equipment.
3. There are no obstructions around the equipment that could direct the arcing exhaust products into an area intended to be protected.
4. The equipment is installed in accordance with the information in the instruction manual and drawings.

Introduction

The SDV-R family of distribution circuit breakers is designed to meet all applicable ANSI, NEMA, and IEEE standards.

Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the proper design and fabrication by Siemens.

The purpose of this instruction manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Contact the nearest Siemens representative if any additional information is desired.

Signal words

The signal words “danger,” “warning,” and “caution” used in this manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

Danger - Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

Warning - Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

Caution - Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury.

Notice - Indicates a potentially hazardous situation that, if not avoided, **may** result in property damage.

Field service operation and warranty issues

Siemens can provide competent, well-trained field service representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details, or telephone Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.

For medium-voltage customer service issues, contact Siemens at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.

General description

Introduction

Siemens type SDV-R distribution circuit breakers are precision-built equipment designed to function efficiently under normal operating conditions. They are designed and manufactured to operate within the parameters established in the relevant ANSI/IEEE C37 and NEMA standards for distribution circuit breakers. Performance requirements of these standards have been met or exceeded by these designs.

Figure 1: Typical types SDV-R-AR and SDV-R distribution circuit breakers

Specific standards which apply include:

- ANSI/IEEE C37.04-2018 Standard for ratings and requirements for ac high-voltage circuit breakers with rated maximum voltage above 1,000 V
- ANSI/IEEE C37.09-2018 Standard test procedure for ac high-voltage circuit breakers with rated maximum voltage above 1,000 V
- ANSI/IEEE C37.20.4-2013 Standard for indoor ac switches (1 kV to 38 kV) for use in metal-enclosed switchgear
- ANSI/IEEE C37.20.7-2017 guide for testing switchgear rated up to 52 kV for internal arcing faults.

The instructions included in this instruction manual are provided to aid you in obtaining longer and more economical service from your Siemens distribution circuit breaker. For proper installation and operation, this information should be distributed to your operators and engineers.

By carefully following these instructions, difficulties should be avoided. However, these instructions are not intended to cover all details of variations that may be encountered in connection with the installation, operation and maintenance of this equipment.

Should additional information be desired, including replacement instruction manuals, contact your local Siemens representative.

To provide additional personal protection in the event of an internal arcing fault, the SDV-R-AR variant is also classified as arc-resistant and has been qualified to carry a type 2B accessibility rating per ANSI/IEEE C37.20.7.

Scope

These instructions cover the installation, operation and maintenance of a Siemens type SDV-R distribution circuit breaker. The equipment designs described in this instruction manual consists of free-standing outdoor distribution circuit breakers for application up to 38 kV. Typical type SDV-R and SDV-R-AR distribution circuit breakers are shown in Figure 1. All diagrams, descriptions, and instructions apply to all of the above classes and designs unless noted otherwise.

Standard construction details of the circuit breaker including the 3AH35-SDV-R operator are given in the appropriate sections of this instruction manual.

Special mechanical and electrical devices, furnished in accordance with purchase order requirements, are covered by supplementary instructions submitted with the customer drawing package and are in addition to this instruction manual.

The equipment furnished has been designed to operate in a system having the circuit capacity specified by the purchaser. If for any reason the equipment is used in a different system or if the short-circuit capacity of the system is increased, the ratings of the equipment, including the momentary rating and the interrupting capacity of the type SDV-R distribution circuit breaker must be checked. Failure on the part of the user to receive approval of intended changes from Siemens may cause the warranty to be void.

This instruction manual applies to SDV-R and SDV-R-AR distribution circuit breakers only. For other equipment, please refer to the relevant instruction manual.

General description

The distribution circuit breaker described in this instruction manual is of the ac high-voltage outdoor circuit breaker type, as defined in the relevant ANSI/IEEE standards. All high-voltage parts excluding roof bushings are completely enclosed within grounded barriers. The secondary control devices and primary circuits are isolated from each other by barriers.

Siemens distribution circuit breakers carry a type designation, as shown in Table 1. This designation may appear on drawings and familiarity with them will simplify communications with the factory.

The SDV-R-AR is classified as arc-resistant, as defined in ANSI/IEEE C37.20.7, and has been qualified to carry a type 2B accessibility rating. The arc-resistant features are intended to provide an additional degree of protection to personnel in close proximity to the equipment in the event of an internal arcing fault while the equipment is operating under normal conditions.

Normal conditions include the “usual service conditions” defined in ANSI/IEEE C37.04 and ANSI/IEEE C37.010.

For the SDV-R-AR arc-resistant version, the following conditions intended to maintain the integrity of the equipment during an internal arcing fault event are in addition:

1. All doors and panels providing access to primary compartments must be closed and properly secured (All bolts installed and tightened. All latches in latched position.)
2. All pressure relief devices must be free to operate as designed.
3. The fault energy available to the equipment must not exceed the internal arcing short-circuit current rating and rated arcing duration of the equipment.
4. There must be no obstructions around the equipment that could direct the arcing exhaust products into an area intended to be protected.
5. The equipment must be properly grounded.
6. All equipment must be properly installed in accordance with information in instruction manuals and drawings.
7. The type SDV-R-AR enclosure must be installed with the arc-exhaust vents at least 79” (2.0 m) above finished grade.

Operator	Type
Stored energy	SDV-R
	SDV-R-AR

Table 1: Distribution circuit breaker designations

Receiving, handling,

Receiving

Each type SDV-R distribution circuit breaker is securely blocked and braced for shipment. It is crated, boxed or covered as required by shipping conditions. If special handling is required, it is so indicated. Relatively delicate instruments, protective relays and other devices are included, and the type SDV-R distribution circuit breaker must be handled carefully when unloading.

Inspection and unpacking

Inspect the equipment as soon as possible after receipt for any damage that may have occurred in transit. Before unpacking, examine the package itself, as a damaged package may indicate damage to the contents of the package. Be careful when unpacking equipment. The use of sledgehammers and crowbars may damage the finish, or the equipment itself. Use nail pullers. After unpacking, examine equipment for any possible damage. Check the shipping manifest to be certain that all items have been received.

Note: If there is a shortage, make certain it is noted on the freight bill and contact the carrier immediately. Notify Siemens medium- voltage customer service at +1 (800) 333-7421 (+1 (423) 262-5700 outside the U.S.) of any shortage or damage.

Shipping damage claims

Important: The manner in which visible shipping damage is identified by consignee prior to signing the delivery receipt can determine the outcome of any damage claim to be filed.

Notification to carrier within 15 days for concealed damage is essential if loss resulting from unsettled claims is to be eliminated or minimized.

1. When shipment arrives, note whether equipment is properly protected from the elements. Note trailer number on which the equipment arrived. Note blocking of equipment. During unloading, make sure to count the actual items unloaded to verify the contents as shown on the delivery receipt.
2. Make immediate inspection for visible damage upon arrival and prior to disturbing or removing packaging or wrapping material. This should be done prior to unloading when possible. When total inspection cannot be made on vehicle prior to unloading, close inspection during unloading must be performed and visible damage noted on the delivery receipt. Take pictures if possible.
3. Any visible damage must be noted on the delivery receipt and acknowledged with the driver's signature. The damage should be detailed as much as possible. It is essential that a notation "possible internal damage, subject to inspection" be included on delivery receipt. If the driver will not sign the delivery receipt with damage noted, the shipment should not be signed for by the consignee or their agent.
4. Notify Siemens immediately of any damage, at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.
5. Arrange for a carrier inspection of damage immediately.

and storage

Important: Do not move equipment from the place it was set when unloading. Also, do not remove or disturb packaging or wrapping material prior to carrier damage inspection. Equipment must be inspected by carrier prior to handling after receipt. This eliminates loss due to claims by carrier that equipment was damaged or further damaged on site after unloading.

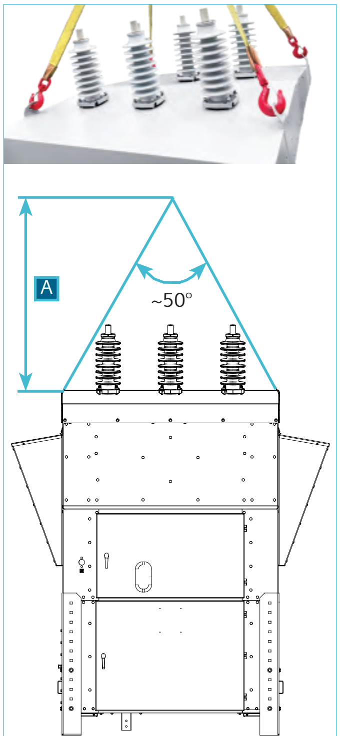
6. Be sure equipment is properly protected from any further damage by covering it properly after unloading.

7. If practical, make further inspection for possible concealed damage while the carrier's inspector is on site. If inspection for concealed damage is not practical at the time the carrier's inspector is present, it must be done within 15 days of receipt of equipment. If concealed damage is found, the carrier must again be notified and inspection made prior to taking any corrective action to repair. Also notify Siemens immediately at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.

8. Obtain the original of the carrier inspection report and forward it along with a copy of the noted delivery receipt to Siemens at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S. Approval must be obtained by Siemens from the carrier before any repair work can be performed. Before approval can be obtained, Siemens must have the above referenced documents. The carrier inspection report and/or driver's signature on the delivery receipt does not constitute approval to repair.

Note: Shipments are not released from the factory without a clear bill of lading. Approved methods are employed for preparation, loading, blocking and tarping of the equipment before it leaves the Siemens factory. Any determination as to whether the equipment was properly loaded or properly prepared by shipper for over-the-road travel cannot be made at the destination. If the equipment is received in a damaged condition, this damage to the equipment must have occurred while en route due to conditions beyond Siemens control. If the procedure outlined above is not followed by the consignee, purchaser or their agent, Siemens cannot be held liable for repairs. Siemens will not be held liable for repairs in any case where repair work was performed prior to authorization from Siemens.

Important: Packaging materials could be flammable. Do not expose packing material to open flames or high temperatures. Disposal regulations vary from locality to locality and may be modified over time. Specific regulations and guidelines should be verified at the time of waste processing to ensure that current requirements are being fulfilled. For specific assistance in understanding and applying regional regulations and policies or manufacturer's recommendations, refer to the local Siemens service representative for additional information.



Value A dimensions in inches (mm)
38.0 kV 1,200 A-2,000 A
61 (1,550)

Figure 2: Lifting type SDV-R distribution circuit breaker with crane

Lifting and moving

There are a number of methods that can be used in handling the type SDV-R distribution circuit breaker that, when properly employed, will not damage the type SDV-R distribution circuit breaker. The handling method used will be determined by conditions and available equipment at the installation site. Lifting with a crane using a sling and lifting lugs is the preferred method of handling; however, overhead obstructions often dictate that other methods must be used. Forklift trucks may be used prior to removal of wooden skids. Verify the forklift blades pass completely through the wooden skid under the circuit breaker.

Each type SDV-R distribution circuit breaker has provisions for attaching lifting cables. Lifting lugs are provided, which are designed for use with a lift sling or hooks of the proper size and a crane of adequate height and capacity. Refer to the type SDV-R distribution circuit breaker nameplate for the weight.

Lifting type SDV-R distribution circuit breaker with crane

The recommended lifting of type SDV-R distribution circuit breakers is by means of cables connected to an overhead crane. The cables are connected to the lifting lugs on the top of the type SDV-R distribution circuit breaker as illustrated in Figure 2: Lifting type SDV-R distribution circuit breaker with crane. A crane with enough height should be used so the load angle on the lifting cable will be approximately 50° when viewed from the front or rear.

Storage

When it is necessary to store a type SDV-R distribution circuit breaker in an area exposed to the weather or under humid conditions, energize the space heaters provided and make certain that any vents are uncovered to allow air to circulate. If at all possible, install the type SDV-R distribution circuit breaker at the permanent location even though it may be some time before the equipment is used. It is also recommended that the type SDV-R distribution circuit breaker receives periodic inspection during storage.

Access to the heater circuit is gained by opening the door to the relay and control compartment. Refer to the wiring diagram drawing for space heater circuit connections. Lubricate hinges and other moving parts.

⚠ WARNING

Heavy weight.

Can result in death, serious injury or property damage.

Observe all handling instructions in this instruction manual to prevent tipping or dropping of equipment.

Installation

Preparation for installation
Prior to installation of the type SDV-R distribution circuit breaker, careful design, planning, and construction of the foundation or base on which the circuit breaker will rest must be made. A thorough analysis and careful construction may alleviate many problems at the time of installation, and during operation. It is important that a relatively level surface be provided capable of supporting the weight of the type SDV-R distribution circuit breaker, and 0.75-inch diameter anchor bolts are recommended.

Figure 4: Anchoring type SDV-R distribution circuit breaker on page 13 illustrates typical locations for anchor bolts. No special leveling procedures are required.

Prior to installation of a type SDV-R distribution circuit breaker, study this instruction book and the circuit breaker drawings, such as general arrangement/ outline drawing, schematic diagram, connection diagrams, current transformer connection diagram, electrical bill of material, and nameplate engraving.

Special attention should be given to the foundation information contained in this instruction manual as well as the information provided on the equipment drawings. Verify the foundation conforms to the requirements described in this instruction manual and the general arrangement/outline drawing.

The type SDV-R distribution circuit breaker is shipped with the legs attached. The legs must be set to the desired height.

Setting leg height
The type SDV-R distribution circuit breaker is shipped with the legs set to a low level (and on some units, turned outward). The legs must be removed and installed correctly.

Remove the legs from the enclosure (if shipped turned outward). Raise the enclosure and install the legs at the desired height.

The legs must be installed and turned inward, so that the two sides of the each leg are adjacent to the enclosure sides and the hole at the bottom of the leg is inside the perimeter of the enclosure, as in Figure 3: Outline drawing on page 12.

Use anti-seize compound (Loctite* 77164 or 77124 nickel anti-seize) on the 1/2-13 SAE stainless steel cap screws used to secure the legs to facilitate removal of the legs should it be required in the future. Torque the 1/2-13 SAE hardware to 50-75 ft-lbs (80-102 Nm)

The height (as installed) between the mounting surface (foundation) and the bottom of the enclosure must be at least 4″ (102 mm) and no higher than 28″ (711 mm).

The type SDV-R-AR circuit breaker must be installed with the arc-exhaust vents at least 79″ (2.0 m) above finished grade.

High-seismic installations
Figure 3: Outline drawing on page 12 shows optional cross-braces installed for high-seismic requirements.

Cross braces can be installed if the bottom of the enclosure is at least 12″ (330 mm) above the foundation.

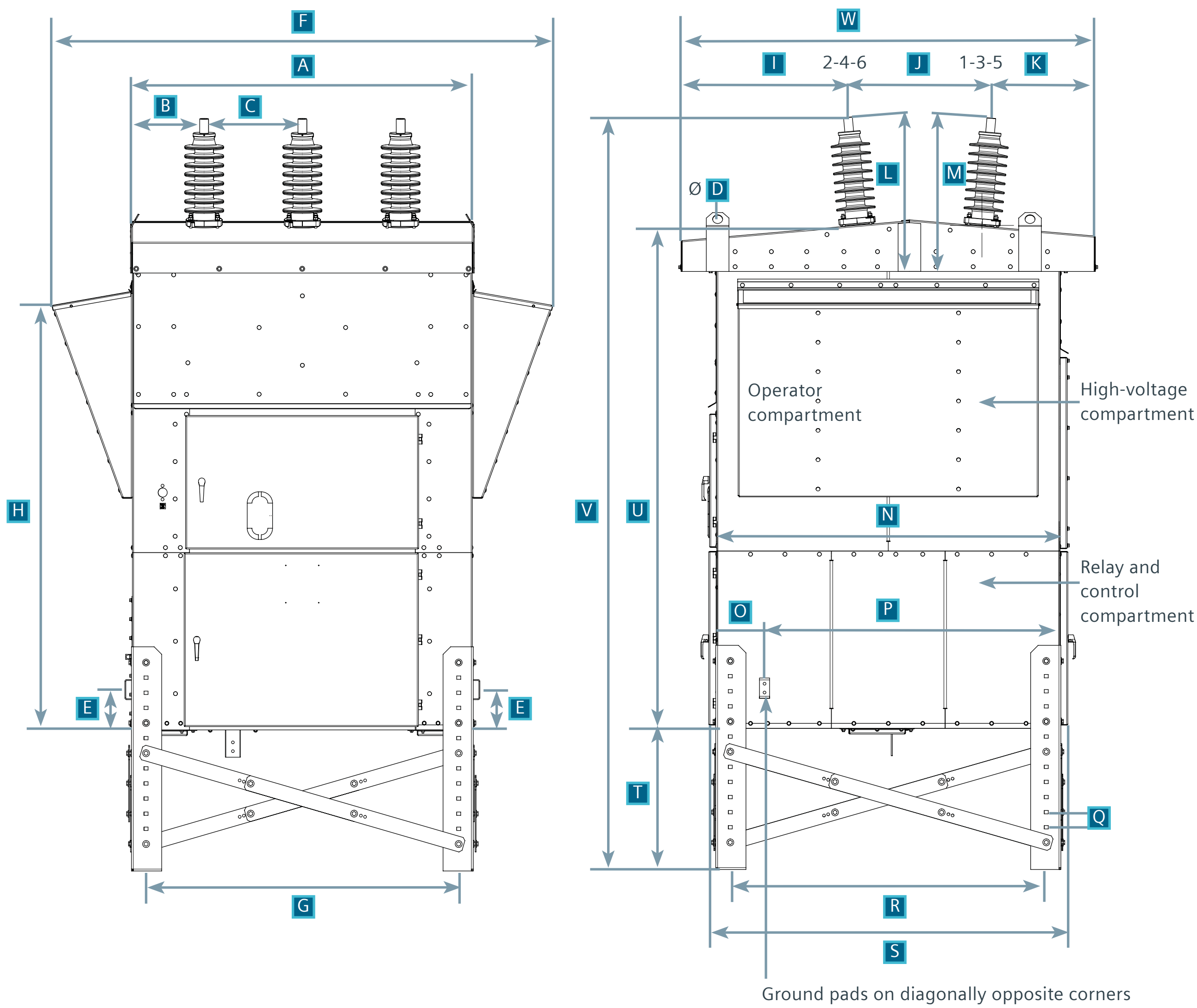
The cross braces consist of steel links that are adaptable for all installation heights (from 13″ (330 mm) to 28″ (711 mm). Install the cross braces as shown in the illustration. The end of the link with a single hole is bolted to the lowest hole on the leg. The opposite link is bolted with the single-hole end bolted to one of the two highest exposed holes in the leg below the enclosure. The highest hole or second highest hole is used, as necessary to allow alignment. Then, bolt the two links together towards the middle, using whichever set of holes align.

When optional cross braces are furnished, install all eight cross braces (four sets) to obtain the required seismic performance.

Location
The circuit breaker should be located so that it is readily accessible for manual operation and inspection. Ample clearance should be provided for doors and panels to swing open, or to be removed for servicing the circuit breaker.

* Loctite is a registered trademark of Henkel Corporation.

Figure 3: Outline drawing[1]



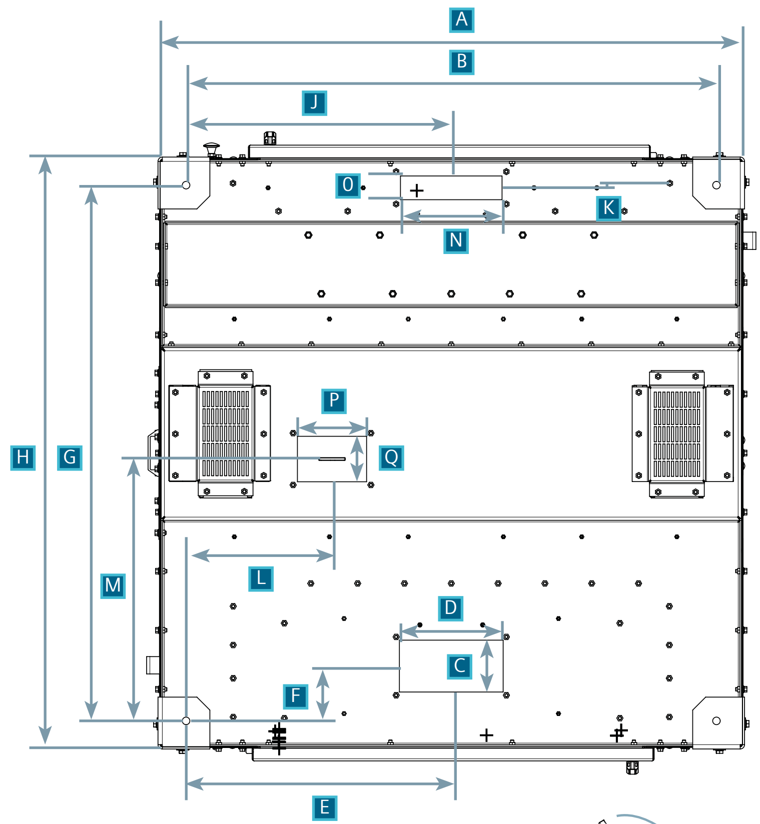
Item	38.0 kV 1,200 A- 2,000 A	Item	38.0 kV 1,200 A-2,000 A	Item	38.0 kV 1,200 A-2,000 A	Item	38.0 kV 1,200 A-2,000 A
A	68.2 (1,733)	G	61.5 (1,561)	M	5.0°	S	71.3 (1,810)
B	14.6 (371)	H	84.2 (2,140)	N	67.8 (1,721)	T	28.0 (711)
C	19.5 (495)	I	33.1 (841)	O	9.3 (237)	U	99.9 (2,538)
D	2.0 (51)	J	28.5 (723)	P	58.4 (1,484)	V	149.4 (3,795)
E	8.0 (203)	K	20.6 (525)	Q	3.0 (76)	W	82.2 (2,089)
F	99.4 (2,524)	L	5.0°	R	62.1 (1,578)		

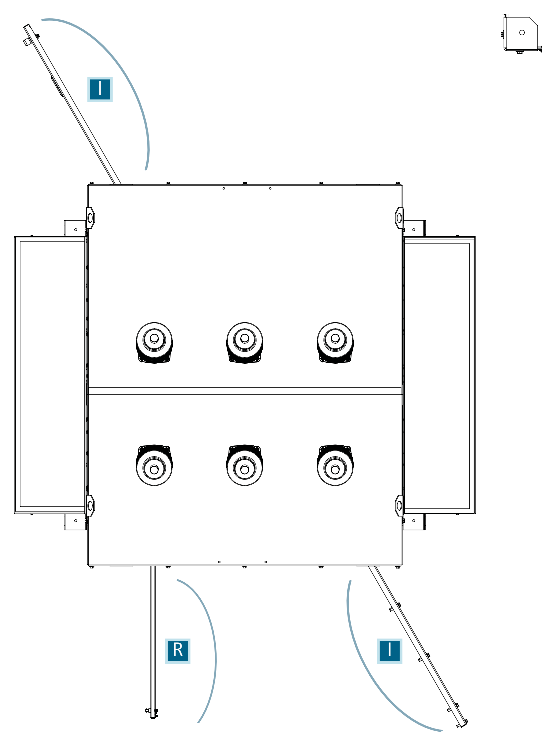
Note 1: Shown with optional cross-bracing for high-seismic loading, and with legs installed at maximum height 28" (711 mm).

Note 2: Unit must be installed with the arc-exhaust vents at least 79" (2.0 m) above finished grade.

Dimensions in inches (mm)

Figure 4: Anchoring type SDV-R-AR distribution circuit breaker





Item	38.0 kV 1,200 A-2,000 A	Item	38.0 kV 1,200 A-2,000 A	Item	38.0 kV 1,200 A-2,000 A
A	67.4 (1,714)	G	62.1 (1,578)	M	30.4 (771)
B	61.5 (1,561)	H	68.1 (1,731)	N	0.8 (298)
C	6.0 (152)	I	120°	O	2.8 (70)
D	12.0 (305)	J	30.7 (781)	P	8.0 (203)
E	30.7 (781)	K	0.4 (9)	Q	5.3 (134)
F	6.4 (163)	L	16.9 (430)	R	90°

Dimensions in inches (mm)

Electrical connections

DANGER

Hazardous voltages and high speed moving parts.

Will cause death, serious injury or property damage.

Do not work on energized equipment and SDV-R integral ground switch is not meant to be a personnel safety ground. Always de-energize and ground high-voltage conductors before working on or near them. The user must make all ground connections before making high-voltage connections, adjust the circuit breaker height to ensure compliance with safety codes for electrical clearance, and assure that the arc-exhaust vents are at least 79” (2.0 m) above finished grade.

Important: An induced voltage can be present on the load side of an open vacuum interrupter. To minimize any potential hazards to operating personnel, the ground connections must be connected before the high voltage connections. Separate connections for the grounding switch and enclosure ground must be used.

Ground connections

Grounding pads on diagonally opposite corners of the enclosure are provided for connecting the cabinet to ground. A ground pad is provided on the bottom surface of the enclosure for connecting the grounding switch terminals to ground. This ground pad must be rotated from the “shipping” position to the “installed” position as shown in Figure 5: Ground switch connection pad installation on page 15 by reusing the M12 hardware supplied and tightening the bolts to 52 ft-lb (70 Nm).

The grounding conductors should be at least 4/0 AWG conductor for all ground connections. A good low-resistance ground is essential for adequate protection and for proper functioning of electronic components such as protective relays. Connections to ground pads must be made in such a manner that a reliable ground connection is obtained.

Consult latest National Electrical Code® or National Electric Safety Code® for ground connection standards.

Primary lead connections

The primary leads must be routed to the bushing terminals to maintain adequate dielectric clearance between different phase conductors and to ground. Conductors must be supported so that the circuit breaker bushings are not subjected to excessive strains, both during normal service and in the event of a short-circuit condition. The leads should be sized to have a capacity at least equal to the maximum operating current of the circuit and within the rating of the type SDV-R distribution circuit breaker. Connections are to be made to the bolted aerial lug terminals of the bushings (normally customer supplied unless otherwise specified) and must be securely tightened to a clean, bright surface to assure good contact.

Secondary control wiring

All secondary control wiring installed by the factory is neatly routed and secured in place. Complete all field connections in a similar manner. Check that the protective relay panel (if so equipped) clears any additional wiring installed.

A conduit panel opening is provided in the bottom of the relay and control compartment for the connection of control circuits. The control wires should be run separately from high-voltage wiring to prevent inductive coupling between them and should be sized for full operating current to avoid a drop in voltage below that specified on the nameplate. All conduits should be sealed off at their entrance to the relay and control compartment.

Terminal blocks are provided inside the relay and control compartment for the connections necessary for the control wiring and protective relay panel (if so equipped). Terminal blocks for current transformer wiring are located in the relay and control compartment and wires can easily be routed from the conduit panel opening in the relay and control compartment to the current transformer circuit terminal blocks in the relay and control compartment. Consult the connection diagrams for the location of connection terminal points for each circuit.

Connection diagrams are provided with each type SDV-R distribution circuit breaker and will be found in the pocket inside the relay and control compartment door.

DANGER

Hazardous voltages.

Will cause death, serious injury or property damage.

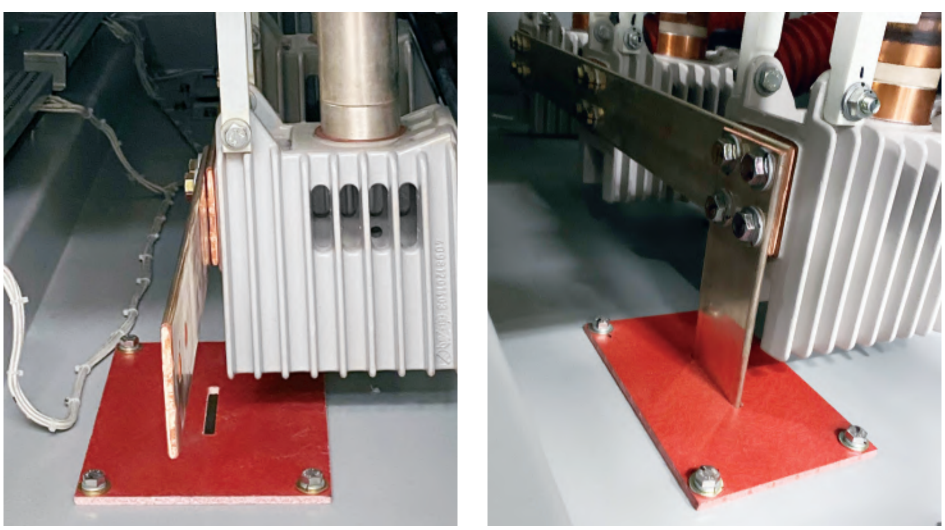
Do not operate current transformers with the secondary open circuited. Current transformers must be either connected to a load or short circuited. Current transformer secondary circuits also must be grounded.

Current transformers (CTs)

Figure 6: Type SDV-R distribution circuit breaker with interphase barriers and bushing current transformers installed in primary compartment on page 16 illustrates the location of bushing (toroidal) CTs installed in the primary compartment of a type SDV-R distribution circuit breaker. The roof bushings pass through the CTs. Up to two CTs may be mounted around each roof bushing. The bushing CT connections are wired to separate terminal blocks located in the relay and control compartment.

Phase barriers

Phase barriers are provided on all type SDV-R distribution circuit breakers as shown in Figure 6: Type SDV-R- distribution circuit breaker with interphase barriers and bushing current transformers installed in primary compartment. These plates of insulating material provide suitable electrical insulation between the primary circuit elements.

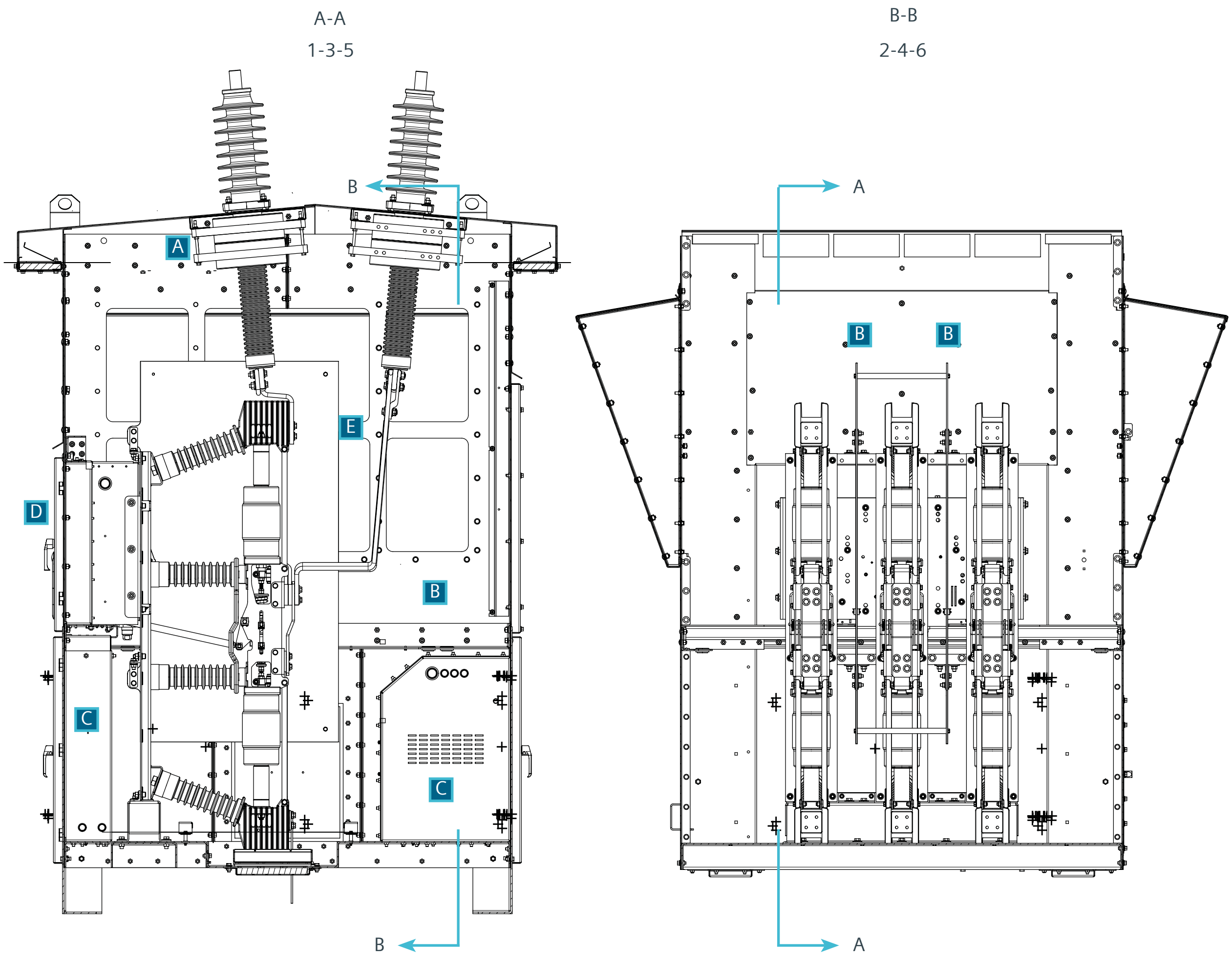


Transport position

Installed position

Figure 5: Ground switch connection pad installation

Figure 6: Type SDV-R-AR distribution circuit breaker with interphase barriers and bushing current transformers installed in primary compartment



Item	Description
A	Bushing current transformer (one per bushing shown)
B	Phase barriers
C	Relay and control compartment
D	Operator compartment
E	High-voltage compartment

Inspections, checks and tests

DANGER

Hazardous voltages and high speed moving parts.

Will cause death, serious injury or property damage.

Read instruction manuals, observe safety instructions and use qualified personnel.

Introduction

This section provides a description of the inspections, checks and tests to perform on the SDV-R and SDV-R-AR distribution circuit breakers prior to operation.

Inspections, checks and tests without control power

SDV-R and SDV-R-AR vacuum circuit breakers are normally shipped with the primary contacts open, the ground switch contacts closed, and the springs discharged. However, prior to starting the inspection process, it is critical to first verify that the control power is de-energized, the spring-loaded mechanisms are in the discharged condition and the circuit breaker main contacts are open.

De-energizing control power

To de-energize the control power, open the disconnect device in the relay and control compartment. Figure 7: Relay and control and operator compartments for type SDV-R-AR circuit breaker with stored-energy operator on page 18 presents the location of this disconnect in a standard type SDV-R or SDV-R-AR distribution circuit breaker.

The control power disconnect device is normally a fused knife switch. However, in some outdoor circuit breakers, a molded-case circuit breaker or pullout-type fuse holder may be used in lieu of the fused knife switch.

Opening the fused knife switch or molded-case circuit breaker or removing the pullout-type fuse holder accomplishes the desired result: control power is disconnected.

Spring-discharge check

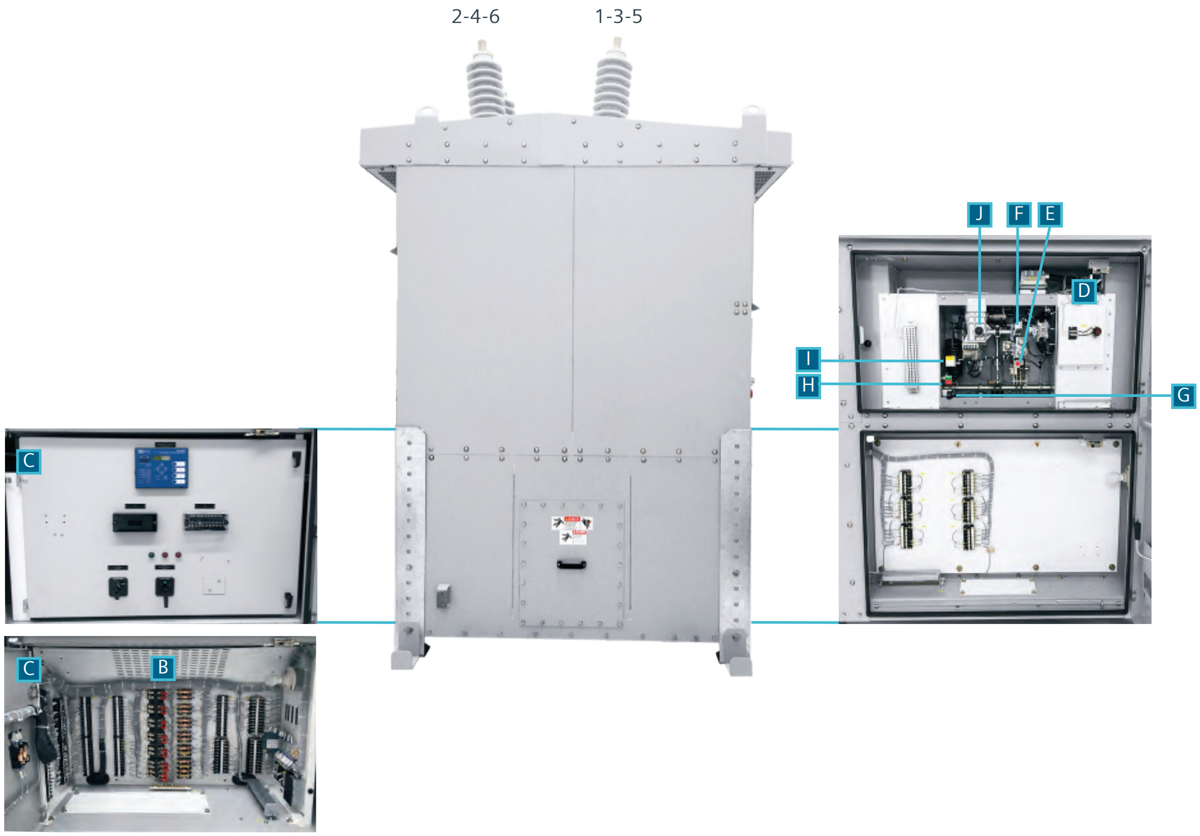
The spring-discharge check consists of simply performing the following tasks in the order given. This check assures both the tripping and closing springs are fully discharged.

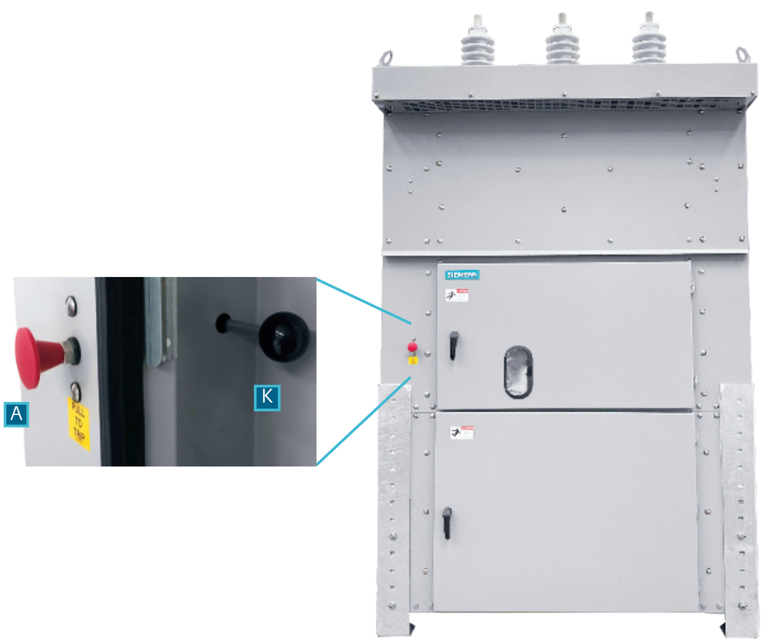
1. De-energize control power.
2. Press red OPEN/TRIP button on the operating mechanism.
3. Press black CLOSE button on the operating mechanism.
4. Again press red OPEN/TRIP button on the operating mechanism.
5. Verify spring condition indicator shows DISCHARGED.
6. Verify main contact status indicator shows OPEN.

Physical inspections

1. Verify the rating of the circuit breaker is compatible with the system.
2. Perform a visual shipping damage check. Clean the circuit breaker of all shipping dust, dirt, and foreign material.

Figure 7: Relay and control and operator compartments for type SDV-R circuit breaker with stored-energy operator





Item	Description
A	External manual trip
B	Control disconnect device
C	Relay and control compartment (shown with relay swing panel open and closed)
D	Operator compartment
E	Push-to-trip pushbutton
F	Push-to-close pushbutton
G	Operations counter
H	OPEN/CLOSE indicator
I	CHARGED/DISCHARGED indicator
J	Opening for manual charging
K	Reset mechanism for external manual trip

Manual spring-charging check

1. Insert the manual spring-charging crank into the manual charge socket as shown in Figure 15: Use of manual spring-operation crank on page 28. Turn the crank until the spring-condition indicator shows the closing springs are charged, and remove the spring charging crank from the socket.
2. Repeat the spring-discharge check presented on page 17.
3. Verify the springs are DISCHARGED and the circuit breaker primary contacts are OPEN by observing the indicator positions.

As-found and vacuum check tests

Perform and record the results of both the as-found insulation test and the vacuum check high-potential test. Procedures for these tests are described in the maintenance section of this instruction manual.

Automatic spring-charging check

Note: A temporary source of control power and test leads may be required if the control power source has not been connected to the circuit breaker. Refer to the specific wiring information and rating label for your circuit breaker to determine the voltage required and where the control voltage signal should be applied.

When control power is connected to the circuit breaker, the closing springs should automatically charge if the control power disconnect is closed.

1. Close the control power disconnect device to energize the circuit breaker control circuit. If not previously charged, the closing spring should charge automatically.
2. Use the manual close and open controls on the circuit breaker operating mechanism (refer to Figure 9: Operator panel controls of circuit breaker and manual charging of closing on page 23) to first close and then open the circuit breaker contacts. Verify the main contact positions visually by observing the OPEN/ CLOSED indicator on the circuit breaker.
3. Verify that the closing springs are CHARGED by observing the indicator position.
4. Repeat the manual-spring discharge check.
5. Verify the springs are DISCHARGED and the SDV-R circuit breaker primary contacts are OPEN by observing the indicator positions.

External manual trip

1. Energize control power circuit by closing knife switch shown in Figure 7: Relay and control and operator compartments for type SDV-R circuit breaker with stored-energy operator on page 18. The spring charging motor should charge the circuit breaker closing springs.
2. Use the manual close control to close the circuit breaker.
3. Pull the external manual trip (red knob on side of enclosure) to trip the circuit breaker, and maintain the external manual trip in the "pulled" condition.
4. Attempt to close the circuit breaker manually and electrically. The circuit breaker should not close.
5. Release the external manual trip, and reset the external manual trip mechanism by pushing on the black reset knob inside the operator compartment. The reset mechanism is to the left of the operating mechanism.
6. After resetting the external manual trip mechanism, attempt to close the circuit breaker manually or electrically. The circuit breaker should close.
7. Open control power circuit by opening knife switch shown in Figure 7: Relay and control and operator compartments for type SDV-R circuit breaker with stored-energy operator on page 18.
8. Repeat the spring discharge check presented on page 18.
9. Verify the springs are DISCHARGED and the circuit breaker primary contacts are OPEN by observing the indicator positions.

Final mechanical inspection and testing without control power

Before the circuit breaker is energized, it must be thoroughly inspected and tested. Correct any deviations before energization.

Inspection

Check the following points:

1. Make a final mechanical inspection of the circuit breaker. Verify the contacts are in the OPEN position, and the closing springs are DISCHARGED.
2. Confirm the circuit breaker is properly set up and reasonably level on its foundation and appropriately anchored to the foundation.
3. Check the tightness of all hardware on the cabinet, adjustable legs, bushings, bus bars and operator mechanism.
4. Verify that the operating mechanism has been properly lubricated.
5. Blocking, supports and other temporary ties remove from circuit breakers, instruments, protective relays, etc.
6. Proper fuses correctly placed.
7. Temporary wiring jumpers (used on the secondaries of current transformers wired to external devices, as shown on wiring diagrams) removed.
8. All ground and grounding connections properly made.
9. Incoming primary and secondary connections properly made and checked for shorts or undesired grounds.
10. Verify all covers, and bolted connectors are securely fastened.
11. Protective relays coordinated with other protective relays and protection devices on the system. Refer to protective relay instructions before making any adjustments.
12. Examine the vacuum interrupters for damage, and wipe the vacuum interrupters and other insulating parts with a clean, dry cloth.
13. All filters in vent areas are clean and free of shipping or construction material.
14. Arc-exhaust vents correctly secured, undamaged, and free to open in the event of an internal arcing fault.
15. Retouch any paint that has been damaged during installation.

NOTICE

Shipping bracing and tag between phase barriers (on units so equipped) may damage circuit breaker.

May result in damage to equipment.

Remove bracing and tag (on units so equipped) before energizing circuit breaker with high voltage.

DANGER

High potential tests employ hazardous voltages.

Will cause death or serious injury.

Follow safe procedures, exclude unnecessary personnel and use safety barriers. Keep away from circuit breaker during application of test voltages. After test completion, ground both ends and the middle ring (if visible) of the vacuum interrupter as well as the ground connection pad to dissipate any static charges.

WARNING

Vacuum interrupters may emit X-ray radiation.

Can result in serious injury.

X-rays can be produced when a high voltage is placed across two circuit elements in a vacuum.

Keep personnel more than six feet away from a circuit breaker under test. All normal metallic doors and panels must be installed during tests.

Testing

Note: No hazardous X-radiation is produced with closed contacts, or with open contacts with rated operating voltage applied. Care should be taken regarding the potential for induced voltages on the ground contact of open ground switch vacuum interrupters.

NOTICE

Excessive test voltages.

May result in damage to equipment.

Do not perform dielectric tests at test voltages exceeding the ratings of the tested equipment.

1. An insulation resistance test is advisable on the control circuit to verify that all connections made in the field are properly insulated.
2. A dielectric test, if possible, should be made on the high-voltage circuit for one minute at the voltages corresponding to the rated voltage of the equipment. The voltage should be raised gradually and the circuit under test should sustain the voltage for one minute.

   When the test is performed with the circuit breaker open, the integrity of the vacuum interrupter will also be verified. If these levels cannot be sustained and there is no other source for the failure, the vacuum interrupter must be replaced.

Rated maximum voltage	Rated power-frequency withstand	Field-test voltage	
kV (rms)	kV (rms)	kV (rms)	kV dc
38.0	80	60	85

Table 2: High-potential test voltages

Note: The dc test voltage is given as a reference only. It represents values believed to be appropriate and approximately equivalent to the corresponding power-frequency withstand test values specified for each voltage rating. The presence of this column in no way implies any requirement for a dc withstand test on ac equipment or that a dc withstand test represents an acceptable alternative to ac withstand tests. When performing dc tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Note: Do not use dc high-potential testers incorporating half-wave rectification. Such devices produce high peak voltages.

These high voltages will produce X-ray radiation. Such devices also show erroneous readings of leakage current when testing vacuum circuit breakers.

Field dielectric tests are recommended when new units are installed, or after major field modifications. The equipment should be put in good condition prior to the field test. It is not expected that equipment shall be subjected to these tests after it has been stored for long periods of time or has accumulated a large amount of dust, moisture or other contaminants without being first restored to good condition.

A dielectric test on secondary and control circuits should be made for one minute at 1,125 volts ac or 1,590 volts dc. The above voltages are in accordance with NEMA Standards.

Note: Certain control devices, such as motors and motor circuits, should be tested at 675 volts ac. Electronic devices should be tested at the voltages specified in the instruction manual for the electronic device.

3. Charge the closing springs manually and push the close pushbutton to close the circuit breaker.
4. Verify main contact status indicator shows CLOSED. Press the trip pushbutton and verify the main contact status indicator shows OPEN. The spring condition indicator should also show DISCHARGED.
5. Energize the control circuits. The motor should run to charge the closing springs, and then automatically turn off.
6. Close the circuit breaker electrically (locally and remotely as applicable) and verify the circuit breaker shows CLOSE and remains closed by checking the main contact status indicator. Note that the motor will immediately run to recharge the closing springs.
7. Trip the circuit breaker electrically (locally and remotely as applicable).
8. Trip the circuit breaker by passing sufficient current (or voltage if applicable) through the coils of protective relays.
9. Repeat the close and trip operations several times to assure proper operation.
10. Check the tripping and closing times from coil energization to contact part or contact make.

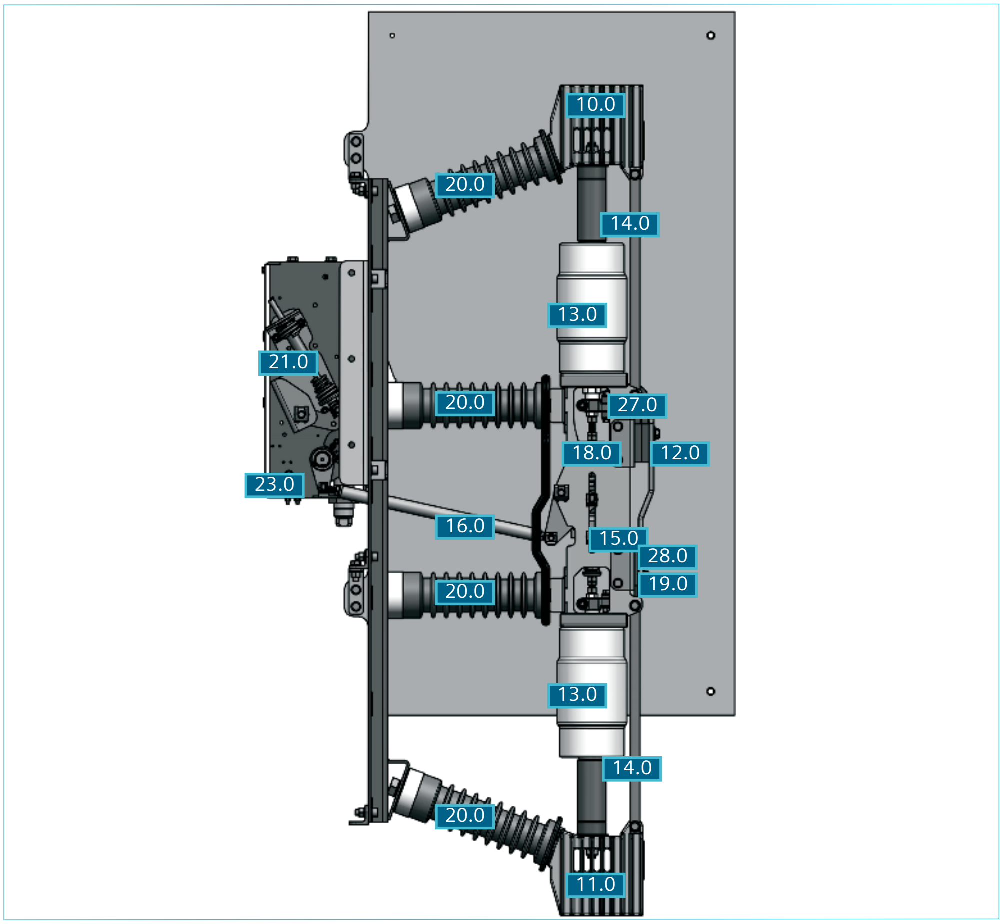
Placing equipment into service

To place equipment in service for the first time proceed as follows:

1. Check that the circuit breaker is OPEN and all control circuits are energized.
2. Check torque of the bolts that secure the roof bushings to the top plate of the type SDV-R distribution circuit breaker. Torque should be in the range of 20-25 ft-lbs (27-34 Nm).
3. Connect primary incoming power source to circuit breaker.
4. Check all instruments, protective relays, meters, etc.
5. Connect as small a load as possible and observe instruments.
6. Gradually connect more load to the equipment while observing instruments until the full load is connected.
7. Check for signs of overheating of primary and secondary circuits and satisfactory operation of all instruments during the first week of operation.

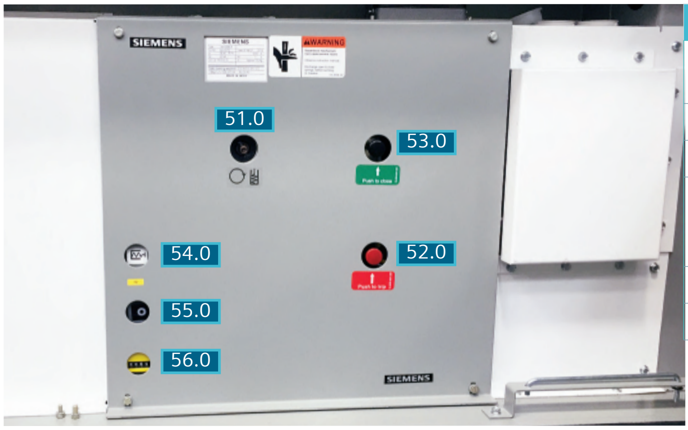
Type 3AH35-SDV-R vacuum circuit breaker operator module

Figure 8: Vacuum circuit breaker operator module



Item	Description
10.0	Vacuum circuit breaker fixed-connection pad
11.0	Ground switch fixed-end connection pad
12.0	Vacuum circuit breaker moving-end connection pad
13.0	Vacuum interrupter
14.0	Insulated strut
15.0	Connector box
16.0	Insulating coupler
18.0	Vacuum circuit breaker contact-pressure spring
19.0	Ground switch contact-pressure spring
20.0	Support insulators
21.0	Opening spring
23.0	Mechanism housing
27.0	Vacuum circuit breaker flexible current link
28.0	Ground switch flexible current link

Figure 9: Operator panel controls of the circuit breaker and manual charging of closing spring



Item	Description
51.0	Manual spring-charging port
52.0	Close pushbutton
53.0	Open pushbutton
54.0	CHARGED/ DISCHARGED indicator
55.0	CLOSE/OPEN indicator
56.0	Operation counter

Introduction

The type 3AH35-SDV-R vacuum circuit breaker operator is intended for stationary applications, such as in the SDV-R and SDV-R-AR outdoor distribution circuit breakers. The type 3AH35-SDV-R circuit breaker operator conforms to the requirements of ANSI/IEEE standards and IEC standards, including C37.04, C37.20.4 and C37.010.

The SDV-R operator includes six vacuum interrupters, a stored-energy operating mechanism, necessary electrical controls, a mechanism housing, and insulating barriers between the vacuum interrupters.

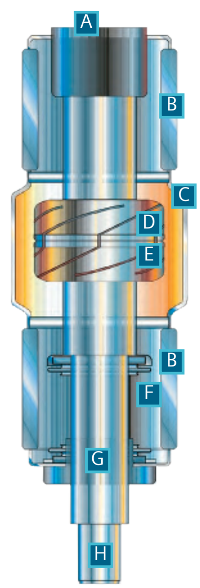
This section describes the operation of each major subassembly of the operator as an aid in the operation, maintenance, and repair of the SDV-R operator.

Vacuum interrupters

The operating principle of the vacuum interrupter is simple. Figure 10: Vacuum interrupter cutaway view is a section view of a typical vacuum interrupter. The entire assembly is sealed after a vacuum is established. The vacuum interrupter stationary contact is connected to the fixed-end pole head of the circuit breaker. The vacuum interrupter movable contact is connected to the flexible shunt associated with the pole carrier and to the mechanism of the circuit breaker operator. The metal bellows provides a secure seal around the movable contact, preventing loss of vacuum while permitting motion of the movable contact along the axis of the vacuum interrupter.

When the two contacts separate, an arc is initiated that continues conduction up to the next current zero. At current zero, the arc extinguishes and any conductive metal vapor that has been created by and supported the arc condenses on the contacts and on the surrounding arc shield.

The materials and shape of the contacts are optimized to achieve the desired arc motion and to minimize switching disturbances.



Item	Description
A	Fixed-contact current connection
B	Ceramic insulator
C	Arc shield
D	Fixed contact
E	Moving contact
F	Metal bellows
G	Guide
H	Moving-contact current connection

Figure 10: Vacuum interrupter cutaway view

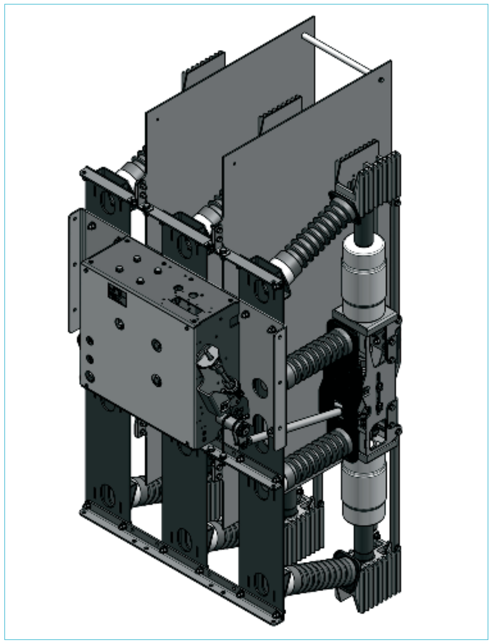


Figure 11: Vacuum circuit breaker operator module

Primary connections

Each operator has three connection pads at the vacuum circuit breaker fixed connection (line-side connection), three connection pads on the flexible connectors associated with the movable contacts of the vacuum interrupters for both the vacuum circuit breaker and the ground switch (load-side connection) and the fixed connection (ground connection). Interconnecting bus in the circuit breaker enclosure connects these connection pads to the roof-bushing terminals.

Phase barriers

Insulating barriers are attached to the circuit breaker operator and provide suitable electrical insulation between the vacuum interrupter and primary conductors and the circuit breaker enclosure.

Stored-energy operating mechanism
The stored-energy operating mechanism of the operator is an integrated arrangement of springs, coils and mechanical devices designed to provide a number of several critical functions. The energy necessary to close and open the contacts of the vacuum interrupters is stored in powerful opening and closing springs. The closing springs are normally charged automatically after a closing operation, but there are provisions for manual charging. The operating mechanism that controls charging, closing and tripping functions is fully trip-free. "Trip-free" requires that the tripping function prevails over the closing function as specified in ANSI/IEEE C37.04.

Vacuum interrupter/operator module
The vacuum interrupter/operator module consists of the three poles, each with its vacuum interrupters and primary insulators mounted to a common operating mechanism housing. This module is shown in Figure 11: Vacuum circuit breaker operator module on page 24.

Construction
Each of the operator poles/phases are fixed to the pole-mounting channel by four cast-resin insulators. The insulators also connect to the circuit breaker and ground switch fixed-end pole heads and to the moving-end connector box that in turn supports the vacuum interrupter. The pole heads are aluminum castings and the connector box is a sheet-steel housing.

The energy-storing mechanism and all the control and actuating devices are installed in the mechanism housing. The mechanism is of the spring stored-energy type and is both mechanically and electrically trip free.

The close-open indicator, closing spring-charge indicator and the operation counter are located on the front of the operator mechanism housing.

The control connector for the control and signaling cables is a multi-contact plug. The mating control plug wiring connects to the terminal blocks in the relay and control compartment.

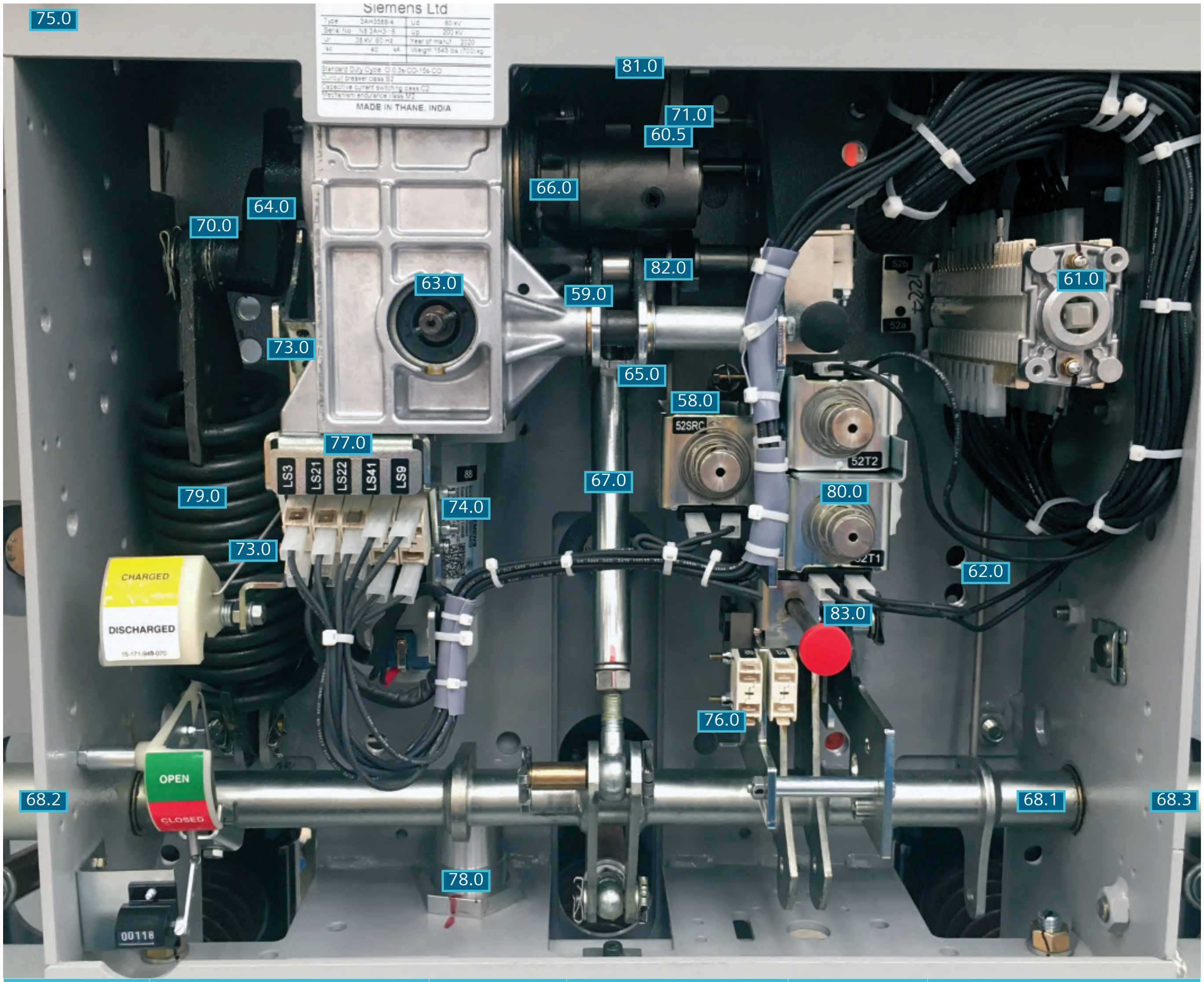
The circuit breaker vacuum interrupter fixed contacts are bolted to the upper fixed-end pole heads while the moving contact ends of the vacuum interrupters are attached to the connector box. The same connector box is attached to the ground switch vacuum interrupter moving contact ends with the fixed-end pole heads connected to the fixed contact ends of the interrupters. This arrangement stabilizes both interrupters against lateral forces via centering rings on the connector box. The external forces due to switching operations and the contact pressure are absorbed by the insulated struts.

The primary current-path assembly consists of the circuit breaker fixed-end pole head, the stationary contact, and the moving contact, plus the flexible connector between the moving contact terminal clamp and the moving-end connection pad. For the grounding path, the assembly contains the circuit breaker moving-end connection pad, the flexible connector and the interrupter moving-contact, the stationary contact and the ground switch fixed-end pole head.

Vacuum interrupter (Figure 10: Vacuum interrupter cutaway view on page 24)
The moving-contact motion is aligned and stabilized by a guide bushing. The metal bellows follows the travel of the contact and seals the vacuum interrupter against the surrounding atmosphere.

Switching operation (Figure 11: Vacuum circuit breaker operator module on page 24, Figure 12: Stored-energy operating mechanism shown in OPEN position on page 26, Figure 13: Mechanical linkage on page 27)
The vacuum interrupters moving contacts are operated by angled levers fixed to the main drive shafts via insulating switching rods and levers. Contact pressure springs are connected directly under the moving contacts. The circuit breaker and ground switch vacuum interrupter movable contacts are connected and move in the same direction. This configuration operates in such a way that as the circuit breaker closes, after a close command is initiated, the ground switch opens at the same time; or vice versa when an open command is initiated.

Figure 12: Stored-energy operating mechanism shown in OPEN position



Item	Description	Item	Description	Item	Description
57.0	Driver (not visible)	67.0	Straight coupling rod	76.0	Lever - trip latch
58.0	Close coil 52SRC	68.1	Main shaft	77.0	Limit switches
59.0	Cam disc	68.2	Extension shafts phase A	78.0	Shock absorber
60.0	Lever	68.3	Extension shafts phase C	79.0	Closing spring
61.0	Auxiliary switch	69.0	Charging shaft	80.0	Trip coil 52T
62.0	Auxiliary switch link	70.0	Crank	81.0	Pawl roller
63.0	Charging mechanism gear box	71.0	Lever	82.0	Close latch pawl
64.0	Control lever	73.0	Linkage	83.0	Trip latch pawl
65.0	Driver lever	74.0	Spring-charging motor (88)		
66.0	Charging flange	75.0	Operator housing		

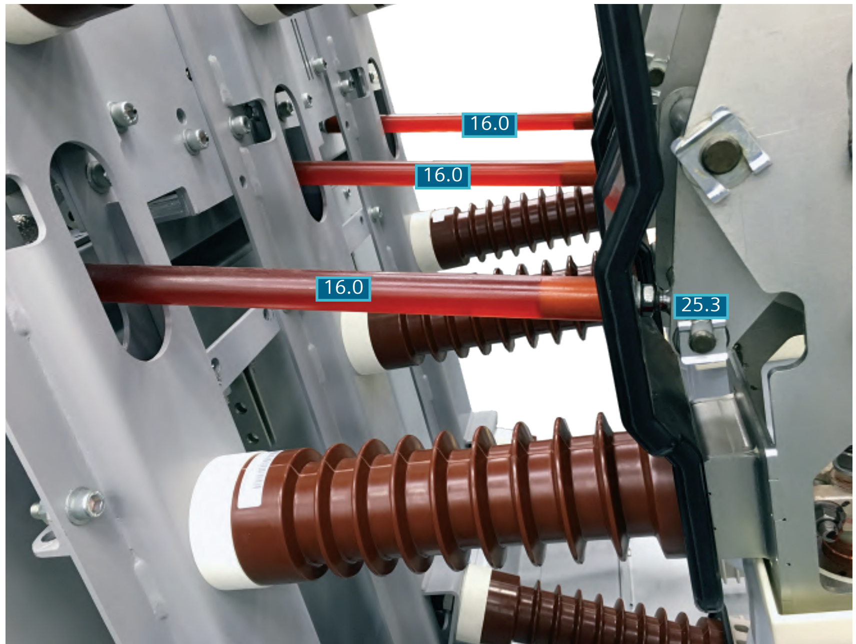
When a circuit breaker closing command is initiated, the closing spring (79.0), that was previously charged by hand or by the motor, actuates the moving contacts through the drive main shafts (68.0), levers (25.1, 25.2 and 25.3), insulating connecting rods (16.0), angular levers and contact pressure springs (19.0 and 18.0).

The forces that occur when the action of the insulating connecting rod (16.0) is converted into the action of the moving contact along the axis of the vacuum interrupter are absorbed by the guide link, that pivots on the pole bottom and the eye bolt. During closing, the opening spring (21.0) and the contact pressure springs (18.0 and 19.0) are charged and latched by pawl. The closing spring (79.0) of the motor-operated circuit breaker is recharged immediately after closing.

In the circuit breaker closed state, the necessary contact pressure is maintained by the circuit breaker contact pressure springs (18.0) and the atmospheric pressure. The contact pressure spring automatically compensates for arc erosion, which is very small. In this state, the ground switch vacuum interrupter contacts are held open.

When an opening command is given, the energy stored in the opening and contact pressure springs is released by pawl (83.0). The residual force of the opening spring (21.0) maintains the moving contacts in the open position.

In the circuit breaker open state, the circuit breaker vacuum interrupter contacts are held open, but the ground switch contacts are closed, and the necessary contact pressure to the ground switch contacts is maintained by the ground switch contact pressure springs (19.0) and the atmospheric pressure.



Item	Description
16.0	Insulating connection rod
25.1	Angled lever phase A (not visible)
25.2	Angled lever phase B (not visible)
25.3	Angled lever phase C

Figure 13: Mechanical linkage

Operating mechanism

The operating mechanism is comprised of the mechanical and electrical components required to:

1. Charge the closing spring with sufficient potential energy to close the circuit breaker and to store opening energy in the opening and contact pressure springs as well as open the ground switch.
2. Mechanisms to release closing and opening actions.
3. Means of transmitting force and motion to each of the vacuum interrupters.
4. Operate all these functions automatically through an electrical charging motor, cutout switches, an anti-pump relay, a close coil, an open coil, and an auxiliary switch.
5. Provide indication of the circuit breaker status (OPEN / CLOSED), spring condition (CHARGED / DISCHARGED) and number of operations.

Construction
The essential parts of the operating mechanism are shown in Figure 12: Stored-energy operating mechanism (circuit breaker shown in OPEN position). The control and sequence of operation of the mechanism is described in Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30.

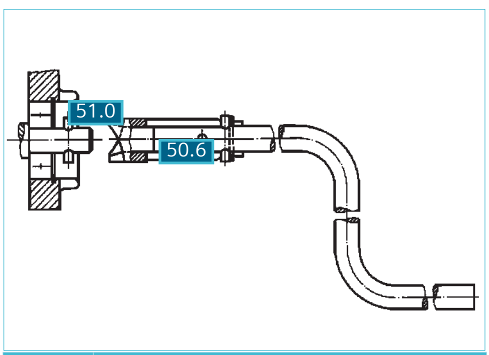
Motor-operating mechanism
Figure 12: Stored-energy operating mechanism (circuit breaker shown in OPEN position) on page 26. The spring-charging motor (88.0) is bolted to the charging mechanism gear box (63.0) installed in the operator housing. Neither the charging mechanism nor the motor require any maintenance.

Mode of operation
The operating mechanism is of the stored-energy, trip-free type. The charging of the closing spring is not automatically followed by the contacts changing position, and tripping function prevails over the closing function.

When the stored-energy mechanism has been charged, the mechanism is ready for a circuit breaker closing operation (ground switch opening operation) at any time. The mechanical energy for carrying out an "Open-Close-Open" sequence for auto-reclosing duty is stored in the closing and opening springs.

Charging
The details of the closing spring charging mechanism are shown in Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30. The charging shaft is supported in the charging mechanism gear box (63.0) but is not coupled mechanically with the charging mechanism. Fitted to it are the crank (70.0) at one end, and the cam (59.0), together with lever (60.0), at the other.

When the charging mechanism is actuated by hand with a hand crank (refer to Figure 15: Use of manual spring-operation crank) or by a motor (74.0), the charging flange (cam) (59.0) turns until the driver (57.0) locates itself in the cutaway part of the charging flange (cam) (59.0), thus causing the charging shaft to follow. The crank (70.0) charges the closing spring (75.0). When the closing spring has been fully charged, the crank actuates the linkage (73.0) via the control lever (64.0) for the closing spring CHARGED indicator (54.0) and actuates the limit switches (77.0) for interrupting the motor supply. At the same time, the lever (60.0) at the other end of the charging shaft is securely locked by the close latch pawl (82.0). When the closing spring is being charged, the charging flange (cam) (59.0) follows along, and it is brought into position for closing when the closing spring is fully charged.



Item	Description
51.0	Manual spring-charging port
50.6	Over-running coupling

Figure 14: Manual hand crank

Item	Description
90.0	Hand crank
51.0	Manual spring-charging port
52.0	Close pushbutton
53.0	Open pushbutton
54.0	CHARGED/DISCHARGED indicator

Figure 15: Use of manual spring-operation crank

Closing

Refer to details shown in Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30 and Figure 16: Operating mechanism section diagram mechanism OPEN/ CLOSE, closing spring DISCHARGED/ CHARGED).

If the circuit breaker is to be closed manually, the closing spring is released by pressing the Close button (52.0). In the case of remote electrical control, the close coil (58.0) unlatches the closing spring (79.0).

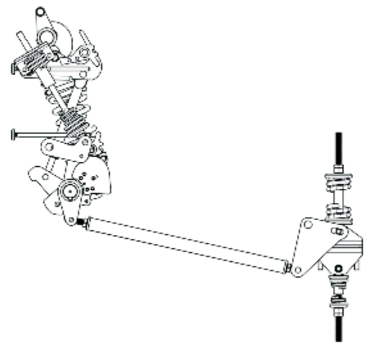
As the closing spring discharges, the charging shaft (69.0) is turned by crank (70.0). The charging flange (cam) (59.0) at the other end of the charging shaft actuates the drive lever (62.6), with the result that jack shaft (68.1) is turned by lever (60.0) via the coupling rod (67.0). At the same time, the levers (25.1), (25.2), and (25.3) fixed on the jack shaft operate the three insulating couplers (16.0) for the circuit breaker poles. Lever (71.0) changes the OPEN/CLOSE indicator (55.0) over to OPEN. Lever (71.0) charges the opening spring (21.0) during closing, and the circuit breaker is latched in the CLOSED position by lever (76.0) with pawl roller (81.0) and by pawl (83.0). Lever (84.0) actuates the auxiliary switch (61.0) through the linkage (62.0). The crank (70.0) on the charging shaft (69.0) moves the linkage (73.0) by acting on the control lever (64.0). The closing spring charged indication is thus canceled, and the limit switches (77.0) switch in the control supply to cause the closing spring to recharge immediately.

Trip-free function for circuit breaker

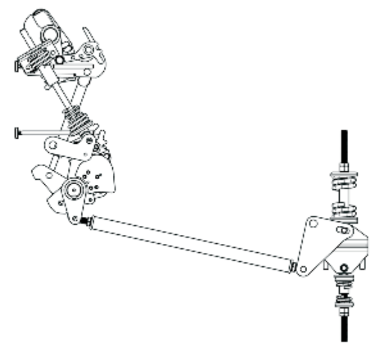
For the circuit breaker, the trip-free function is accomplished by blocking the movement of the close latch pawl (82.0) when the manual trip pushbutton is actuated. The trip-free function is in accordance with ANSI/IEEE C37.04.

Opening

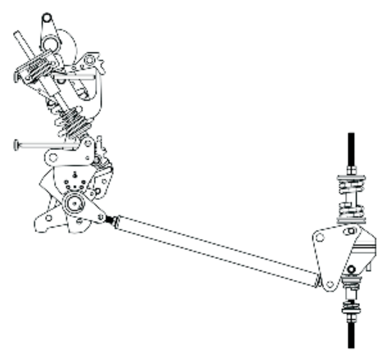
Refer to details shown in Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30. If the circuit breaker is to be opened manually, the opening spring (21.0) is released by pressing the OPEN pushbutton (53.0). In the case of an electrical command being given, the trip coil (80.0) unlatches the opening latch; the sequence being similar to that for closing.



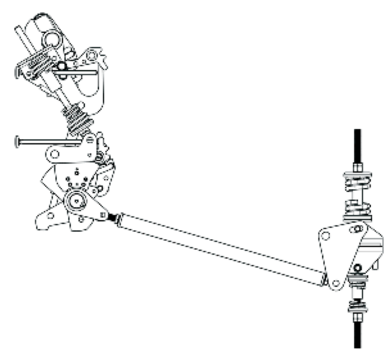
Circuit breaker OPEN,
closing spring DISCHARGED



Circuit breaker OPEN,
closing spring CHARGED



Circuit breaker CLOSED,
closing spring DISCHARGED



Circuit breaker CLOSED,
closing spring CHARGED

Figure 16: Operating mechanism diagram mechanism OPEN/ CLOSE, closing spring DISCHARGED/ CHARGED

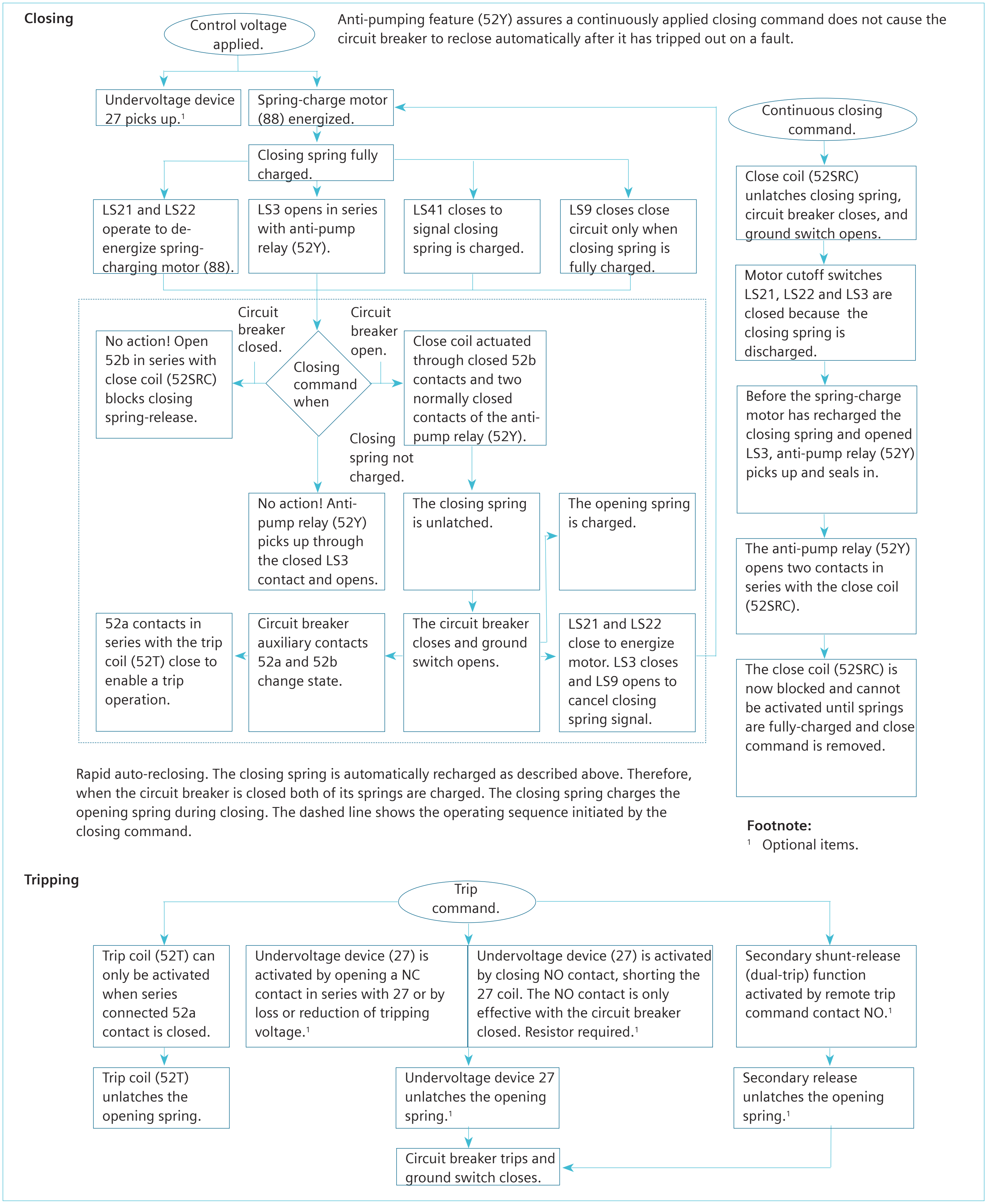
Rapid auto-closing

Since the closing spring is automatically recharged by the motor operating mechanism when the circuit breaker has closed, the operating mechanism is capable of an "Open-Close-Open" duty cycle as required for rapid auto-reclosing.

The operating mechanism is suitable for use in applications with a rated reclosing-time interval of 0.3 seconds, per ANSI/IEEE C37.04.

Important: Although the circuit breaker has rapid auto-reclosing capability, Siemens does not recommend that the SDV-R circuit breaker be used for rapid auto-reclosing applications. The ground switch, being integral to the operator, operates on every operation and may cause unwanted system disturbances.

Figure 17: Operator sequential operation diagram



Manual operation
Electrically operated vacuum circuit breakers can be operated manually if the control supply should fail.

Manually charging the circuit breaker closing spring
Refer to Figure 15: Use of manual spring-charging crank on page 28. Insert the hand crank (90.0) with the over running coupling pushed forward (50.6) through the opening (50.1) onto hand crank coupling (51.0) and turn it clockwise until the closing-spring indicator (54.0) shows CHARGED. The hand crank is coupled with the charging mechanism via an over-running coupling; thus, the operating personnel is not exposed to any risk should the control supply be restored during manual charging.

Manual closing of the circuit breaker
Refer to Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30. Press the close button (52.0). The CLOSE/OPEN indicator (55.0) will then display CLOSED and the closing spring condition indicator (54.0) will now read DISCHARGED.

Manual opening of the circuit breaker
Refer to Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30. The opening spring (21.0) is charged during closing. To open the circuit breaker, press the open pushbutton (53.0) and OPEN will be displayed by indicator (55.0).

The schematic shown in Figure 18: Typical elementary diagram on page 32 is intended to aid in understanding the mechanism operation discussed in this instruction manual. Refer to the schematic diagram furnished with your circuit breaker for specific information.

Close coil (52SRC)
The close coil (3AY1510) is a standard component of the circuit breaker that is used to unlatch the stored energy of the closing spring and thus close the circuit breaker electrically. It is available for either ac or dc operation. After completion of a closing operation, the close coil is de-energized internally. If operated with ac voltage, a rectifier is installed in the circuit breaker

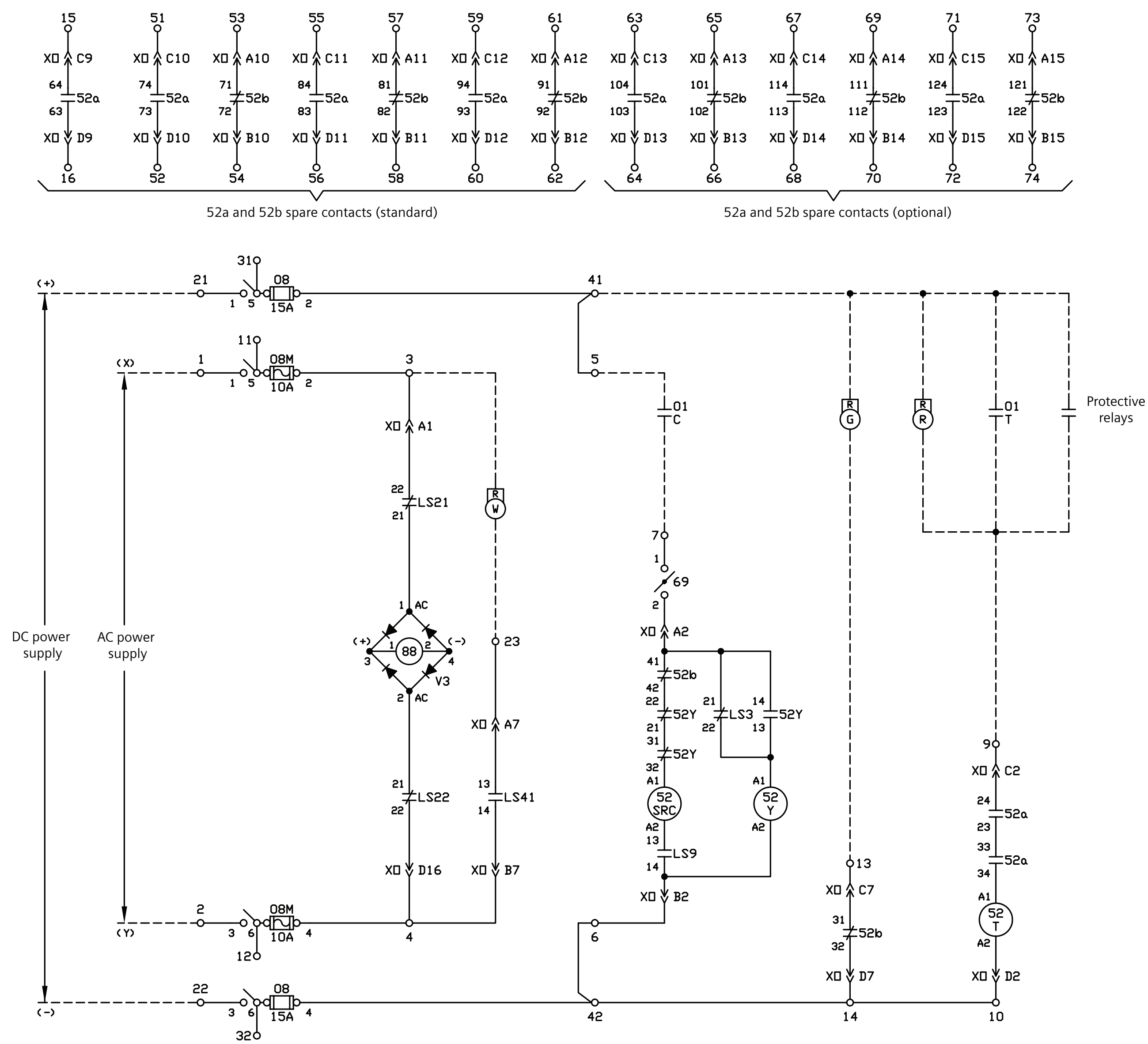
Trip coil (52T)
The trip coil (3AY1510) is a standard component of the circuit breaker. The electrically supplied tripping signal is passed onto the trip-latching mechanism by means of a direct-action solenoid armature and the circuit breaker is thus opened. It is available for either ac or dc operation. After completion of an opening operation, the trip coil is de-energized internally. If operated with ac voltage, a rectifier is installed in the circuit breaker

Figure 18: Typical elementary diagram

Legend:

01/C	Control switch close (remote)
01/T	Control switch trip (remote)
08	Close and trip power disconnect
08M	Motor power disconnect
52a	Auxiliary switch, open when circuit breaker is open
52b	Auxiliary switch, closed when circuit breaker is open
52SRC	Closing spring release coil
52T	Opening spring release coil
52Y	Anti-pump relay
69	Closing cutout switch
88	Spring charge motor
G	Green indicating light (remote)
R	Red indicating light (remote)
LS3	Closing spring position switch, closed when closing spring is discharged
LS9	Closing spring position switch, open when closing spring is discharged
LS21	Motor cutoff switch, closed when closing spring is discharged
LS22	Motor cutoff switch, closed when closing spring is discharged
LS41	Closing spring position switch, open open when closing spring is discharged
W	White indicating light (remote)
XO	Plug connector (operator connections)

Schematic shown with closing springs discharged and circuit breaker open.

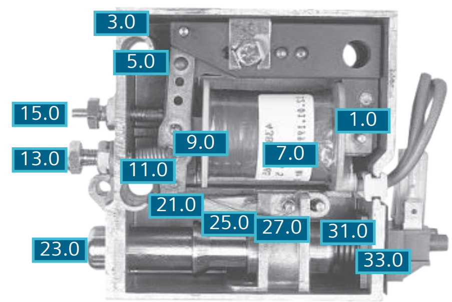


Indirect releases - secondary shunt release (auxiliary trip) (52T1) or undervoltage
The indirect release provides for the conversion of modest control signals into powerful mechanical-energy impulses. It is primarily used to open medium-voltage circuit breakers while functioning as a secondary shunt-release (dual trip) or undervoltage device.

These releases are mechanical energy-storage devices. Their internal springs are charged as a consequence of the circuit breaker mechanism operation. This energy is released upon application or removal (as appropriate) of applicable control voltages (refer to Figure 19: Construction of secondary shunt release (shown charged), Figure 20: Latch details (shown charged) and Figure 21: Undervoltage lock/operate selection on page 34. The secondary shunt-release and undervoltage release mounts to the immediate left of the trip coil (80.0).

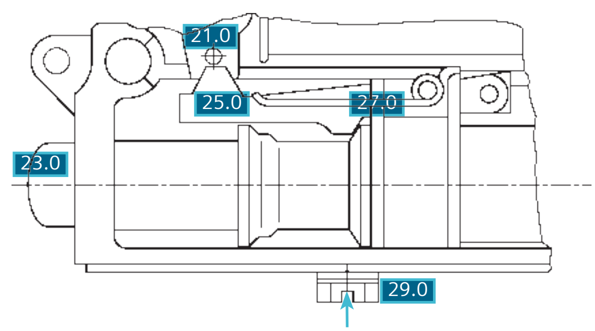
Secondary shunt releases (52T1)
Refer to Figure 19: Construction of secondary shunt release (shown charged). A secondary shunt-release (extra-trip coil) (3AX1101) is used for electrical opening of the circuit breaker by protective relays or manual control devices when more than one trip coil is required. The second trip coil is generally connected to a separate auxiliary supply (dc or ac) from the control supply used for the normal trip coil. An alternate configuration is available where an additional coil identical to the primary coil is used for three-cycle applications.

Undervoltage releases
Refer to Figure 20: Latch details (shown charged) and Figure 21: Undervoltage lock/operate selection on page 34. The undervoltage release (3AX1103) is used for continuous monitoring of the tripping supply voltage. If this supply voltage falls excessively, the undervoltage release will provide for automatic tripping of the circuit breaker. The undervoltage device may be used for manual or relay tripping by employing a contact in series with undervoltage device holding coil. Relay tripping may also be achieved by employing a normally open contact in parallel with the holding coil.



Item	Description
1.0	Magnet core
3.0	Housing
5.0	Mounting holes
7.0	Magnet coil
9.0	Magnet armature
11.0	Tension spring
13.0	Adjusting screw (factory set) for 11.0
15.0	Tripping pin
21.0	Locking pin
23.0	Striker pin
25.0	Latch
27.0	Spring
31.0	Striker-pin spring
33.0	Terminal block

Figure 19: Construction of secondary shunt release (shown charged)



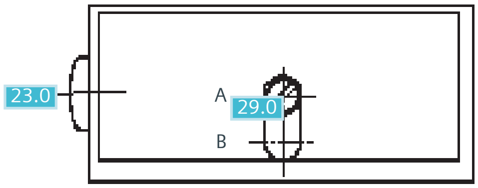
Locked/unlocked selection screw (undervoltage release only)

Item	Description
21.0	Locking pin
23.0	Striker pin
25.0	Latch
27.0	Spring
29.0	Locked/unlocked selection screw

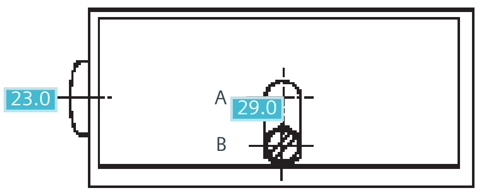
Figure 20: Latch details (shown charged)

If this scheme is used, a resistor must be provided to limit current when the normally open contact is closed. Secondary shunt and undervoltage releases are available for all standard ANSI/IEEE control voltages.

Cancel the lock for the undervoltage release by shifting the locking screw (29.0) from A to B.



Position A: locked



Position B: unlocked (operating position)

Item	Description
23.0	Striker pin
29.0	Locked/unlocked selection screw

Figure 21: Undervoltage lock/operate selection

Construction and mode of operation of secondary shunt-release and undervoltage release

The release consists of a spring-power stored-energy mechanism, a latching device and an electromagnet. Refer to Figure 19: Construction of secondary shunt release (shown charged) and Figure 20: Latch details (shown charged) on page 33 and Figure 21: Undervoltage lock/operate selection.

These elements are accommodated side-by-side in a housing (3.0), with a detachable cover and three through-holes (5.0) for fastening screws. The supply leads for the trip coil are connected to a terminal block (33.0).

The energy-storing mechanism consists of the striker pin (23.0) and its operating spring (31.0), which is mostly located inside the striker pin (23.0). When the spring is compressed, the striker pin is held by a latch (25.0), whose sloping face is forced against the appropriately shaped striker pin (23.0) by spring (27.0). The other end of the latch (25.0) is supported by a partly milled locking pin (21.0), pivoted in the cover sheets of the magnet armature (9.0).

The armature (9.0) is pivoted in front of the poles of the U-shaped magnet core (1.0) and is pulled away from it by the tension spring (11.0).

If the magnet coil (7.0) of the secondary shunt release 3AX1101 is energized by a trip signal, or if the tripping pin (15.0) is mechanically actuated, magnet armature (9.0) is swung against the pole faces. When this happens, the latch (25.0) loses its support and releases the striker pin (23.0) that is forced out by the spring (31.0).

On the undervoltage release 3AX1103, the latch (25.0) is held by the locking pin (21.0) as long as the armature (9.0) is energized. If the circuit of the magnet coil (7.0) is interrupted, the armature (9.0) drops off, thus causing the latch (25.0) to lose its support and release the striker pin (23.0).

Following every tripping operation, the striker pin (23.0) must be reset to its normal position by loading the spring (31.0). This takes place automatically via the operating mechanism of the circuit breaker.

Since the striker pin of the undervoltage release 3AX1103 is latched only when the armature is energized, the undervoltage release is provided with a screw (29.0), for locking the striker pin (23.0) in the normal position for adjusting purposes or for carrying out trial operations during circuit breaker servicing. Position A (locked) disables the undervoltage release. Position B (unlocked) is the normal operating position.

Capacitor trip device

The capacitor trip device is an auxiliary tripping option providing a short-term means of storing adequate electrical energy to ensure circuit breaker tripping. If provided, a capacitor trip device must be located in the outdoor circuit breaker enclosure, as space is not available inside the operator housing. This device is applied in circuit breaker installations lacking independent auxiliary control power or station battery. In such installations, control power is usually derived from the primary source. In the event of a primary ac source fault or disturbance the capacitor trip device will provide short-term tripping energy for circuit breaker opening due to protective relay operation or operation of a circuit breaker control switch.

The capacitor trip converts 120 or 240 Vac control voltage to a dc full-wave voltage that is used to charge a large capacitor to the peak of the converted wave (refer to Figure 22: Capacitor-trip device).

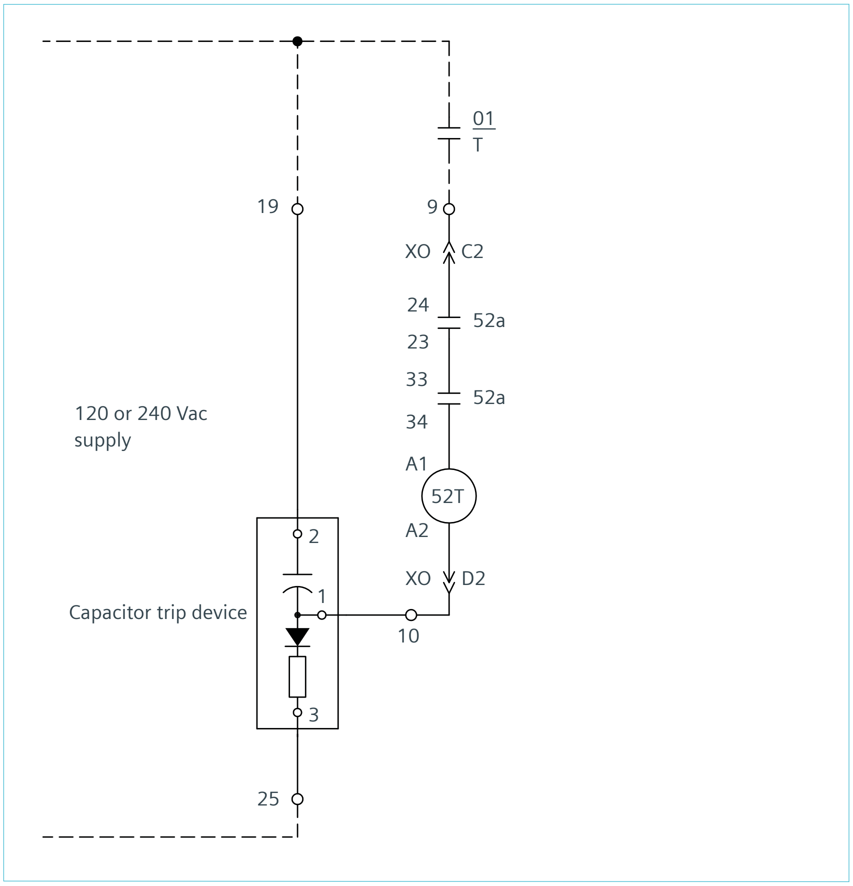


Figure 22: Capacitor-trip device

Shock absorber

Circuit breakers are equipped with a hydraulic shock absorber (78.0) (refer to Figure 17: Stored-energy operating mechanism shown in OPEN position on page 30). The purpose of this shock absorber is to limit overtravel and rebound of the vacuum interrupter movable contacts during the conclusion of an opening operation. The shock absorber action affects only the end of an opening operation.

Auxiliary switch (52a/b)

Figure 17: Stored-energy operating mechanism shown in OPEN position shows the circuit breaker mounted auxiliary switch (61.0). This switch provides auxiliary contacts for control of circuit breaker closing and opening functions. Contacts are available for use in relaying and external logic circuits. This switch is driven by linkage (62.0) connected to the main shaft (68.1). The auxiliary switch contains both “b” (normally closed) and “a” (normally open) contacts. When the circuit breaker is open, the “b” contacts are closed and the “a” contacts are open.

Spring-charging motor (88)

Spring-charging motors (74.0) (refer to Figure 17: Stored-energy operating mechanism shown in OPEN position) are available for either ac or dc operation. If operated with ac voltage, a rectifier is installed in the circuit breaker.

Maintenance

⚠ WARNING

Failure to maintain the equipment can cause death, serious injury, property damage, or product failure, and can prevent successful functioning of connected apparatus.

The instructions contained herein should be carefully reviewed, understood, and followed.

The maintenance tasks in Table x must be performed regularly.

The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel can result in hazardous conditions that can cause death, serious injury, or property damage.

Follow all safety instructions contained herein.

⚠ DANGER

Hazardous voltages and high speed moving parts.

Will cause death, serious injury or property damage.

Do not work on energized equipment and SDV-R integral ground switch is not meant to be a personnel safety ground. Always de-energize and ground high-voltage conductors before working on or near them. The user must make all ground connections before making high-voltage connections, adjust the circuit breaker height to ensure compliance with safety codes for electrical clearance, and assure that the arc-exhaust vents are at least 79" (2.0 m) above finished grade.

Circuit breaker type	Number of years/ closing operations (whichever comes first)
SDV-R	Five years/ 10,000 operation
SDV-R-AR	

Table 3: Maintenance and lubrication intervals

Inspection and maintenance intervals
Periodic inspections and maintenance are essential to obtain safe and reliable operation of the type SDV-R distribution circuit breaker.

The following procedures along with the troubleshooting chart at the end of this section, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the type SDV-R distribution circuit breaker.

When type SDV-R distribution circuit breakers are operated under "usual service conditions," maintenance and lubrication is recommended at five-year intervals or at the number of operations indicated in Table 3: Maintenance and lubrication intervals, whichever occurs first. "Usual" and "unusual" service conditions for outdoor medium-voltage circuit breakers are defined in ANSI/IEEE C37.04 and ANSI/ IEEE C37.010. Generally, "usual service conditions" are defined as an environment in which the equipment is not exposed to excessive dust, acid fumes, damaging chemicals, salt air, rapid or frequent changes in temperature, vibration, high humidity and extremes of temperature.

The definition of "usual service conditions" is subject to a variety of interpretations. Because of this, the user is best served by adjusting maintenance and lubrication intervals based on your experience with the equipment in the actual service environment. With the inclusion of an optional heater monitoring circuit to provide a means of ensuring the space heaters are functioning properly, the maintenance interval can be extended beyond what is shown in Table 3.

Regardless of the length of the maintenance and lubrication interval, Siemens recommends that circuit breakers should be inspected and exercised annually.

For the safety of maintenance personnel as well as others who might be exposed to hazards associated with maintenance activities, the safety-related work practices of NFPA 70E (especially chapter 1) should always be followed when working on electrical equipment.

Maintenance personnel should be trained in the safety practices, procedures and requirements that pertain to their respective job assignments.

This instruction manual should be reviewed and retained in a location readily accessible for reference during maintenance of this equipment.

The user must establish a periodic maintenance program to ensure trouble-free and safe operation.

The frequency of inspection, periodic cleaning and preventive maintenance schedule will depend upon the operation conditions. NFPA Publication 70B, "Electrical Equipment Maintenance" may be used as a guide to establish such a program.

Note: A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.

WARNING

Hazardous voltages and high speed moving parts.

Can cause death, serious injury or property damage.

All replacement of circuit breaker components must be performed with the circuit breaker completely de-energized and the springs discharged.

Recommended hand tools

Type SDV-R distribution circuit breakers use both standard SAE (U.S. customary) and metric fasteners. Metric fasteners are used for the vacuum interrupters and in the vacuum interrupter/operator module. SAE (U.S. customary) fasteners are used in most other locations. This list of hand tools describes those normally used in disassembly and re-assembly procedures.

SAE (U.S. customary):

- Socket and open-end wrenches: 5/16”-7/8” and 7 mm-55 mm
- Deep sockets: 19 mm and 24 mm
- Hex keys: 3/16” and 1/4”; 8 mm
- Torque wrench: 0 to 150 ft-lbs (0 to 200 Nm)
- Screwdrivers: 0.032 x 1/4” wide and 0.055” x 7/16” wide
- Drift pins: 1/8”, 3/16”, and 1/4”
- Pliers
- Light hammer
- Mechanic’s mirror
- Flashlight
- Drift pins
- Retaining rind pliers (external type, tip diameter 0.038”).

Recommended maintenance and lubrication

Periodic maintenance and lubrication should include all the tasks shown in Table 4: Periodic maintenance and lubrication tasks on page 39.

The list of tasks does not represent an exhaustive survey of maintenance steps necessary to ensure safe operation of the equipment.

Particular applications may require further procedures. Should further information be desired or should particular problems arise not covered sufficiently for the Purchaser’s purposes, the matter should be referred to Siemens at +1 (800) 333-7421 or 1-423-262-5700 outside the U.S.

Note: A preventive maintenance program is not intended to cover reconditioning or major repair, but should be designed to reveal, if possible, the need for such actions in time to prevent malfunctions during operation.

De-energize the circuit breaker

Prior to performing any inspection or maintenance checks, the circuit breaker must be de-energized, isolated, and grounded. Principal steps are outlined below for information and guidance.

Be sure that the circuit breaker and its mechanism are disconnected from all electric power, both high voltage and control voltage, before it is inspected or repaired.

After the circuit breaker has been disconnected (isolated) from power lines, attach the grounding leads properly before touching any of the circuit breaker parts.

De-energize the control power to the circuit breaker.

Table 4: Periodic maintenance and lubrication tasks

Sub-assembly	Item	Inspect for
Primary power path	Vacuum interrupter	1. Cleanliness. 2. Contact erosion. **Note:** Perform with manual-spring checks. 3. Vacuum integrity. **Note:** Perform with high-potential tests.
	Vacuum interrupter contact resistance	1. Record contact resistance with contacts closed and check at each maintenance interval to monitor condition.
Vacuum interrupter operator mechanism	Cleanliness	1. Dirt or foreign material.
	Fasteners	1. Tightness of nuts and other locking devices.
	(Stored-energy) manual-spring check	1. Smooth operation of manual charging, manual closing and manual tripping.
	Lubrication	1. Evidence of excessive wear. 2. Lubrication of wear points.
Electrical controls	Wiring	1. Mechanical damage or abrasion.
	Terminals and connectors	1. Tightness and absence of mechanical damage.
	Close and trip solenoids, anti-pump relay and auxiliary switches	1. Automatic charging. 2. Close and trip with control power.
High-potential test	Primary circuit-to-ground and between primary disconnects	1. 60-second withstand.
	Control circuit-to-ground	1. 60-second withstand.
Insulation	Barriers and all insulating components	1. Cleanliness. 2. Cracking, crazing, tracking or other sign of deterioration.
Space heaters	Space heaters	1. Correct operation.

Checks of primary power path

The primary power path consists of the vacuum interrupters, the fixed-end and moving-end connections to the enclosure bus system and the roof-mounted bushings. These components must be checked for cleanliness and condition. The vacuum interrupters must also be checked for vacuum integrity.

Check torque of the bolts that secure the roof bushings to the top plate of the circuit breaker. Torque should be in the range of 20-25 ft-lbs (27-34 Nm).

If a bushing has been removed or is being replaced, tighten bushing mounting bolts in a cross pattern, progressively increasing torque from one-third to two-thirds to full torque.

Use anti-seize compound (Loctite* 77164 or 77124 nickel anti-seize) on the threads of the roof studs to facilitate future removal of a bushing should it become necessary.

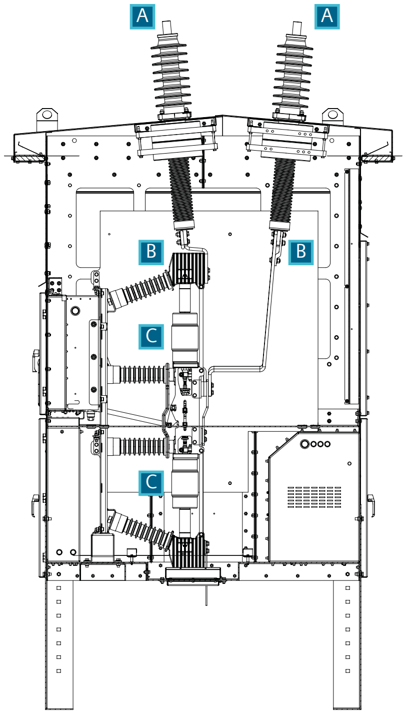
For connections between the bottom of the bushing and the bus bar, torque the 1/2-13 SAE grade 5 steel hardware to 50-75 ft-lbs (80-102 Nm).

For connections between the bus bars and the pole heads and connector box of the operator, torque M12 x 1.75 grade 8 bolts to 52 ft-lbs (70 Nm).

Some test engineers prefer to perform the contact-erosion check during the manual spring-charging check of the stored-energy operator, since charging of the springs is necessary to place the contacts in the CLOSED position. Also, the vacuum integrity check is usually performed in conjunction with the high-potential tests.

These instructions follow the recommendation that these tests contact erosion/manual spring-charging check, and vacuum integrity/high-potential tests) will be combined as described.

* Loctite is a registered trademark of Henkel Corporation.



Item	Description
A	Bushings
B	Bus
C	Vacuum interrupter

Figure 23: Side view of type SDV-R distribution circuit breaker

Cleanliness check
Figure 23 is a side view of the type SDV-R distribution circuit breaker showing the vacuum interrupters, bus connections, and roof bushings. All of these components must be cleaned and free of dirt or any foreign objects. Use a dry lint-free cloth. For stubborn dirt, use a clean cloth dipped in isopropyl alcohol (except for cleaning the vacuum interrupters). For stubborn dirt on a vacuum interrupter use a cloth and warm water and a small amount of mild liquid-household detergent as a cleaning agent. Dry thoroughly using a dry lint-free cloth.

Also, inspect the bus work for any evidence of loose bolts, bushings for any evidence of damage, and flexible connectors for tightness and absence of mechanical damage, burning, or pitting.

Checks of the stored-energy operator mechanism
The stored-energy operator checks are divided into mechanical and electrical checks for simplicity and better organization. The first series of checks determine if the basic mechanism is clean, lubricated and operates smoothly without control power. The contact erosion check of the vacuum interrupter is also performed during these tasks.

Maintenance and lubrication
Table 3 on page 36 presents the recommended maintenance intervals for the type SDV-R distribution circuit breakers. These intervals assume that the circuit breaker is operated under "usual service conditions" as discussed in ANSI/IEEE C37.04 and elaborated in ANSI/IEEE C37.010. When actual operating conditions are more severe, maintenance periods may occur more frequently. The operations counter on the front panel of the circuit breaker records the number of operations. The maintenance and lubrication interval is the lesser of the number of closing operations or the time interval since last maintenance.

The vacuum interrupter operator mechanism is shown in Figure 24 with the front cover removed to show construction details. The movable end of the closing spring is connected to a crank arm. The movable end of the opening spring is connected to the jack shaft by a pull rod.

Clean the entire stored-energy operator mechanism with a dry, lint-free cloth.

Check all components for evidence of excessive wear. Place special attention upon the closing spring-crank and the insulating couplers and linkages.

Lubricate all non-electrical moving or sliding surfaces indicated with a light coat of synthetic grease or oil. Lubricants composed of ester oils and lithium thickeners will be generally compatible.

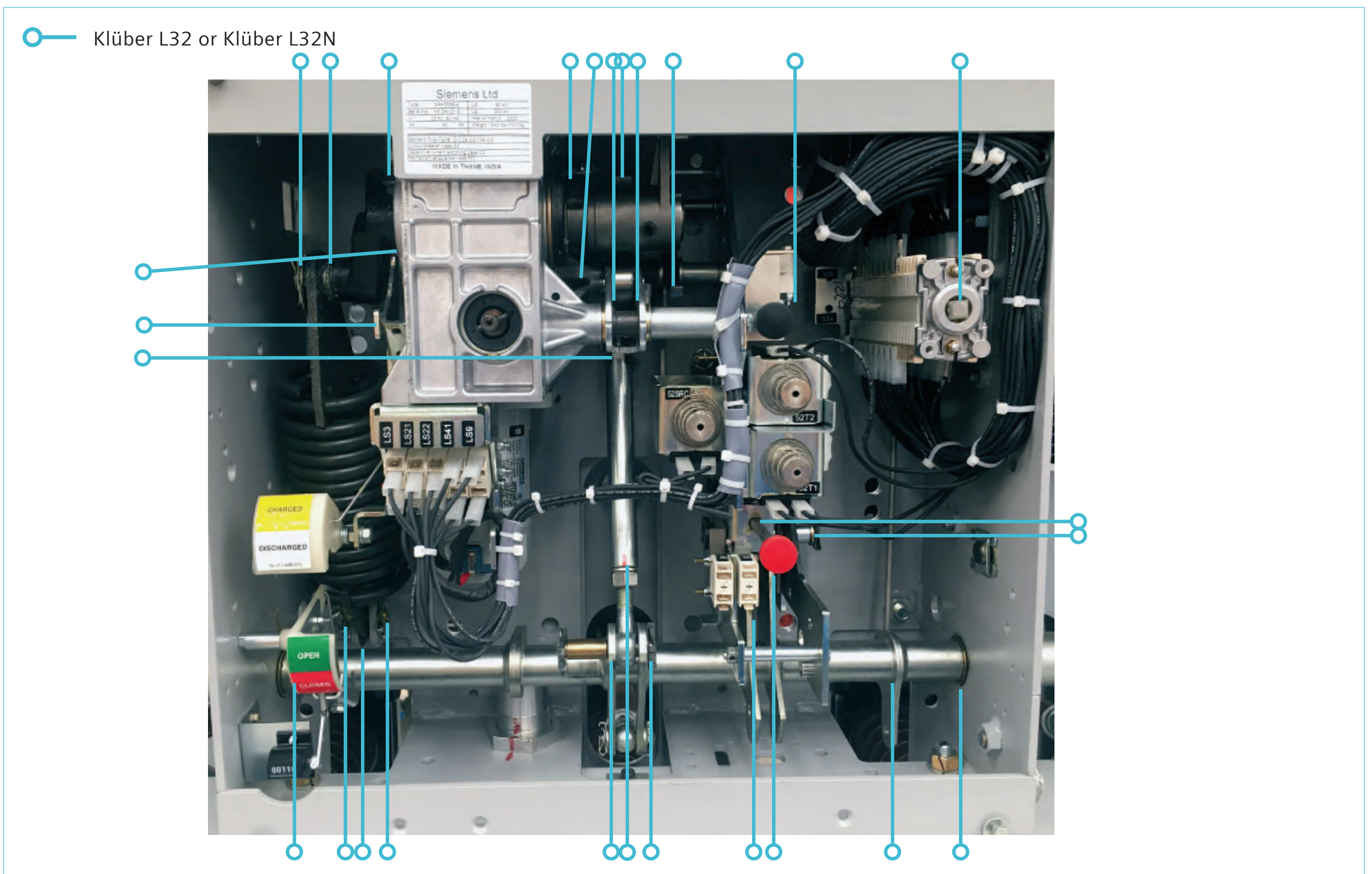
For all lubrication (except electrical moving or sliding surfaces), use one of the following:

- Klüber Isoflex Topas L32 (part 3AX11333H)
- Klüber Isoflex Topas L32N (spray) (part 15-172-879-201).

Source: Klüber Isoflex Topas L32 or L32N: Klüber Lubrication North America L.P. www.klueber.com

Fastener check
Inspect all fasteners for tightness. Both locknuts and retaining rings are used. Replace any fasteners that appear to have been frequently removed and replaced.

Figure 24: Operator mechanism lubrication



WARNING

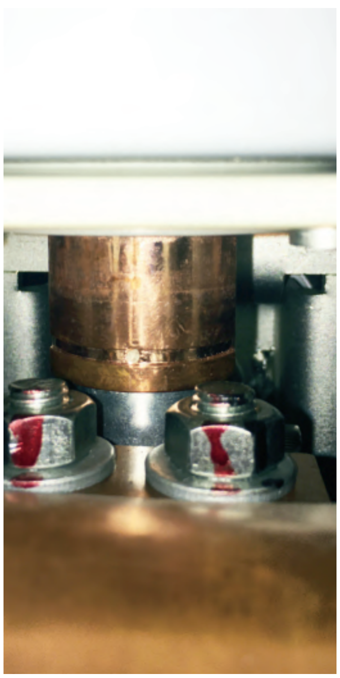
High-speed moving parts.

Can result in serious injury.

Tripping spring is charged. If trip latch is moved, the stored-energy springs will discharge rapidly.

Stay clear of circuit breaker components that are subject to sudden, high-speed movement.

Figure 25: Contact-erosion mark



Manual spring-charging and contact-erosion checks

Perform the manual spring-charging check contained in the section describing the installation check and initial functional tests. The key steps of this procedure are repeated here:

1. Insert the hand-charging crank into the manual-charge socket at the front of the operator control panel. Turn the crank clockwise to charge the closing spring. Continue cranking until the CHARGED flag appears in the window of the spring indicator.
2. Press the Close (black) pushbutton. The contact-position indicator on the operator control-panel should indicate that the circuit breaker contacts are closed.
3. Perform the contact-erosion check. Contact erosion occurs when high fault-currents are interrupted. Determination of acceptable contact condition is checked by the visibility of the white contact-erosion mark shown in Figure 25: Contact-erosion mark dot (shown with circuit breaker OPEN). The white contact-erosion mark is located on the movable stem of the vacuum interrupters, near the plastic guide-bushing.

   The contact-erosion check procedure is:

   - Be sure the circuit breaker primary contacts are closed.
   - Observe the white contact-erosion mark (refer to Figure 17) on each pole. When any part of the white contact-erosion mark is visible, contact wear is within acceptable limits. A mechanic's mirror is a convenient means for viewing the contact-erosion mark on each vacuum interrupter.
4. Press the Open (red) pushbutton after completing the contact-erosion check. Visually verify the discharged condition of the closing spring and that the circuit breaker contacts are open.
5. Press the Close (black) pushbutton. Nothing should happen. The manual-spring check should demonstrate smooth operation of the operating mechanism.

Electrical control checks

The electrical controls of the circuit breaker should be checked during inspections to verify absence of any mechanical damage, and proper operation of the automatic spring-charging and close and trip circuits.

Unless otherwise noted, all of these tests are performed without any control power applied to the circuit breaker.

DANGER

Hazardous voltage and high-speed moving parts.

Will cause death, serious injury, and property damage.

Do not bypass interlocks or otherwise make interlocks inoperative. Interlocks must be in operation at all times.

Read instruction manual, observe safety instructions, and use qualified personnel.

Check of wiring and terminals

1. Physically check all the circuit breaker wiring for evidence of abrasion, cuts, burning or mechanical damage.
2. Check all terminals to be certain they are solidly attached to their respective device.

Automatic spring-charging check (control power required)

Repeat the automatic spring-charging check on page 19 described in the section describing the installation checks and initial functional tests.

Primary tasks of this check are:

1. The circuit breaker must be energized with control power for this check.
2. Energize the control-power source.
3. When control power is connected to the circuit breaker, the closing spring should automatically charge. Visually verify that the closing spring is charged.

Note: A temporary source of control power and test leads may be required if the control-power source has not been connected to the circuit breaker. When control power is connected to the circuit breaker, the closing spring should automatically charge.

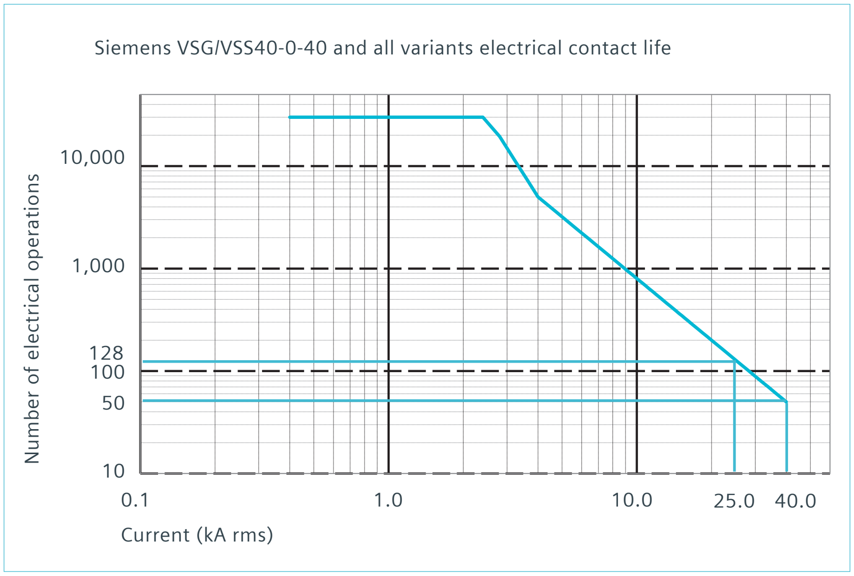
Electrical close and trip check (control power required)

A check of the circuit breaker control circuits shall be performed. This check is made with the control circuit of the circuit breaker energized.

1. Once the circuit breaker springs are charged, operate the circuit breaker electrical close command (via pushbutton, control switch, or equivalent means). Verify by both the sound of the circuit breaker closing and by the main contact status indicator that the circuit breaker contacts are closed.
2. As soon as the circuit breaker has closed, the automatic spring-charging process is repeated.
3. After a satisfactory close operation is verified, operate the circuit breaker electrical close command (via pushbutton, control switch, or equivalent means). Verify by both the sound of the circuit breaker opening and by the main contact status indicator that the circuit breaker contacts are open.
4. After a satisfactory open operation is verified, hold the circuit breaker manual trip button and apply and maintain an electrical close signal. The circuit breaker should close, immediately trip, the close spring should charge, and the circuit breaker should not attempt to close again.

Completion of these checks demonstrates satisfactory operation of auxiliary switches, internal relays and open and close coils.

Figure 26: VSG/VSS40-0-40-A1 electrical contact life



Checks of the spring-charging motor
No additional checks of the spring-charging motor are necessary. If it is necessary to remove or replace the spring-charging motor, torque the motor-mounting hardware to 7.3-8 ft-lb (10-11 Nm).

Anti-pump relay
If it is necessary to remove the connections to the anti-pump relay, use care to avoid damaging the relay. Replace the relay if the relay terminals are damaged or loose in the relay body.

Vacuum interrupters
The life expectancy of vacuum interrupters is a function of the numbers of interruptions and magnitude of current interrupted.

The vacuum interrupter contact life curve (Figure 26: VSG/VSS40-0-40-A1 electrical contact life) is offered as a guide to expected life.

WARNING

Vacuum interrupters may emit X-ray radiation.

Can result in serious injury.

Keep personnel more than six feet away from a circuit breaker under test.

DANGER

High-potential tests employ hazardous voltages.

Will cause death and serious injury.

Follow safe procedures, exclude unnecessary personnel, and use safety barriers. Keep away from the circuit breaker during application of test voltages.

High-potential tests
The next series of tests (vacuum-integrity test and insulation tests) involve use of high-voltage test equipment. The SDV-R operator under test should be inside a suitable test barrier equipped with warning lights.

Vacuum-integrity check
A high-potential test is used to verify the vacuum integrity of the vacuum interrupters. The test is conducted on the circuit breaker vacuum interrupter primary contacts in the open position (ground switch vacuum interrupter contacts closed) and with ground switch vacuum interrupter primary contacts in the OPEN position (circuit breaker vacuum interrupter contacts closed).

Vacuum integrity test procedure

1. Observe safety precautions listed in the danger and caution advisories. Construct the proper barrier and warning light system.
2. Ground the frame of the circuit breaker and ground each pole not under test.
3. Apply test voltage (60 kV ac rms or 85 dc) across each circuit breaker vacuum interrupter for one minute (circuit breaker open) or across each ground switch vacuum interrupter for one minute (circuit breaker closed).
4. If the vacuum interrupter sustains the test voltage for that period, the vacuum integrity has been verified.

Note: The dc test voltage is given as a reference only. It represents values believed to be appropriate and approximately equivalent to the required power-frequency withstand test value from ANSI/IEEE C37.04. The presence of this information in no way implies any requirement for a dc withstand test on ac equipment or that a dc withstand test represents an acceptable alternative to ac withstand tests. When making dc tests, the voltage should be raised to the test value in discrete steps and held for a period of one minute.

Do not use dc high-potential testers incorporating half-wave rectification. Such devices produce high-peak voltages.

These high voltages will produce X-ray radiation. Such devices also show erroneous readings of leakage current when testing vacuum circuit breakers.

Note: This test includes not only the vacuum interrupter, but also the other insulation components in parallel with the vacuum interrupter. These include the post insulators and the insulating coupler, as well as the insulating (tension) struts between the upper and lower vacuum interrupter supports. If these insulation components are contaminated or defective, the test voltage will not be sustained. If so, clean or replace the affected components, and retest.

If dc high-potential tests are used, note the following:

- If a dc test indicates loss of vacuum, reverse the polarity of the test leads and retest.
- If the second test is successful, the vacuum interrupter has adequate vacuum integrity.
- If the second test also indicates loss of vacuum integrity, replace the vacuum interrupter.

As-found insulation and contact-resistance tests
As-found tests verify the integrity of the circuit breaker insulation system. Megger* or insulation-resistance tests and contact-resistant tests conducted on equipment prior to installation provide a basis of future comparison to detect changes in the protection afforded by the insulation system, and in the integrity of the current-carrying path. A permanent record of periodic as-found tests enables the maintenance organization to determine when corrective actions are required by watching for significant deterioration in insulation resistance, or increase in contact resistance.

Insulation and contact-resistance test equipment
In addition to the high-potential test equipment capable of test voltages, the following equipment is also required:

- AC high-potential tester with test voltage of 1,500 volts, 60 Hz.
- Test equipment for contact-resistance tests.

* Megger is a registered trademark of Megger Group, Ltd.

Insulation and contact-resistance test procedure

1. Observe safety precautions listed in the danger and caution advisories for the vacuum integrity check tests.
2. Close the circuit breaker. Ground the ground switch terminal and the circuit breaker enclosure and ground each pole not under test. Use manual charging, closing and tripping procedures.
3. Apply 60 kV ac rms or 85 dc high-potential test voltage between a primary conductor of the circuit breaker pole and ground for one minute.
4. If no disruptive discharge occurs, the insulation system of the circuit breaker is satisfactory.
5. After test completion, ground both ends of the vacuum interrupters and the arc chamber of each vacuum interrupter to dissipate any static charges.
6. Open the circuit breaker. Ground the circuit breaker terminal and frame of the circuit breaker enclosure and ground each pole not under test.
7. Apply 60 kV ac rms or 85 dc high-potential test voltage between a primary conductor of the ground switch pole and ground for one minute.
8. If no disruptive discharge occurs, the insulation system of the ground switch is satisfactory.
9. After test completion, ground both ends of the vacuum interrupters and the arc chamber of each vacuum interrupter to dissipate any static charge.
10. Disconnect the leads to the spring-charging motor.
11. Disconnect secondary circuits for the operating mechanism by disconnecting the multiple pin-plug and connect all pins on the operator side with a shorting wire. Connect the shorting wire to the high-potential lead of the high-voltage tester and ground the circuit breaker enclosure.
12. Starting with zero voltage, gradually increase the test voltage to 1,500 volts rms, 60 Hz. Maintain test voltage for one minute.
13. If no disruptive discharge occurs, the secondary control insulation level is satisfactory.
14. Disconnect the shorting wire, reattach the multiple pin-plug, and reattach the leads to the spring-charging motor.
15. Perform contact-resistance tests of the primary contacts of both the circuit breaker and ground switch circuits. The resistance should not exceed 30 micro-Ohms between the fixed-end connection pad and the moving-end connection pad of the circuit breaker circuit and 60 micro-Ohms between the fixed-end connection pad and the moving-end connection pad of the ground switch circuit (refer to Figure 9 on page 23).

Inspection and cleaning of circuit breaker insulation

1. Perform the spring-discharge check on the circuit breaker. The spring-discharge check consists of:.

- De-energize control power.
- Press red open/trip button on the operating mechanism.
- Press black close button on the operating mechanism.
- Again press red open/trip button on the operating mechanism.
- Verify spring-condition indicator shows DISCHARGED.
- Verify main contact status indicator shows OPEN.
- All controls are on the circuit breaker front panel (refer to Figure 9: Operator panel controls of circuit breaker and manual charging of closing on page 23 and manual charging of closing springs on. Visually verify the discharged condition of the springs.

2. Clean barriers and post insulators using clean cloth and isopropyl alcohol.

NOTICE

Risk of insulation damage with use of incorrect compounds.

May cause equipment dielectric failure.

Use only isopropyl alcohol to clean insulation. Do not use any cleaning compounds containing chlorinated hydrocarbons such as trichlorethylene, perchlorethylene or carbon tetrachloride. These compounds will damage the material used in the barriers and other insulation on the circuit breaker.

Functional tests

Refer to the installation checklist in the installation checks and initial functional tests section of this instruction manual. Functional tests consist of performing at least three manual spring-charging checks and three automatic spring-charging checks. After these tests are complete, and the springs fully discharged, all fasteners and connections are checked again for tightness and condition.

Protective relays and instruments

The type SDV-R distribution circuit breaker can be equipped with a protective relay package supplied on a hinged panel mounted in the front of the relay and control compartment.

To ensure satisfactory operation of protective relays and instruments do not leave device covers off longer than necessary. When a cover has been broken, cover the device temporarily and replace broken cover as soon as possible.

Refer to the wiring and schematic diagrams, and other instruction literature shipped with the circuit breaker for additional specific protective relay requirements.

Equipment surfaces

Inspect the painted surfaces and touch up scratches as necessary. ANSI-61 touch-up paint is available from Siemens. This paint matches the unit and is thinned and ready for use in one pint (473 ml) spray cans.

Inspect interior of unit for entrance of moisture and repair as necessary.

Inspect ventilation filters, clean or replace as appropriate.

Troubleshooting

Introduction

The following procedures along with the troubleshooting charts at the end of this section, provide maintenance personnel with a guide to identifying and correcting possible malfunctions of the type SDV-R distribution circuit breaker.

Table 5: Troubleshooting

Problem	Symptoms		Possible causes and remedies
Circuit breaker fails to close.	Closing spring will not automatically charge.		1. Secondary control circuit is de-energized or control circuit fuses are blown. Check and energize or replace if necessary. 2. Secondary multi-pin plug contacts A1 or D16 are not engaging. Check and replace if required. 3. Damage to wiring, terminals or connectors. Check and repair as necessary. 4. Failure of charging motor (88). Replace if required. 5. Motor cut-off switch LS21 or LS22 fails to operate. Replace if necessary. 6. Mechanical failure of operating mechanism. Check and contact the factory or Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.
	Closing springs charge but circuit breaker does not close.	Closing coil or solenoid (52SRC) fails to energize. No sound of circuit breaker closing.	1. Secondary control circuit de-energized or control circuit fuses blown. Correct as indicated. 2. No closing signal to multi-pin plug pin A2 or contacts A2 and B3 are not engaging. Check for continuity and correct protective relay logic. Replace contacts if required. 3. Failure of anti-pump relay (52Y) contacts 21 to 22, 31 to 32 or 13 to 14. Check and replace as required. 4. Failure of close coil (solenoid) (52SRC). Check and replace as required. 5. Auxiliary switch NC contacts 41 to 42 are open when circuit breaker contacts are open. Check linkage and switch. Replace or adjust as necessary.

Table 5: Troubleshooting (continued)

Problem	Symptoms		Possible causes and remedies
Circuit breaker fails to close.	Closing springs charge but circuit breaker does not close.	Closing coil energizes. Sound of circuit breaker closing is heard, but circuit breaker contacts do not close.	1. Mechanical failure of operating mechanism. Check and contact the factory or Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.
Nuisance or false close	Electrical problem		1. Nuisance or false closing signal to secondary disconnect multi-pin plug contact. Check protective relay logic. Correct as required. 2. (Stored-energy) closing coil (52SRC) terminal A2 is shorted-to-ground. Check to determine if problems are in wiring or coil. Correct as required.
	Mechanical problem		1. Mechanical failure of operating mechanism. Check and contact the factory or Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.
Circuit breaker will not trip	Tripping coil or solenoid (52T) does not energize. There is no tripping sound.		1. Secondary control power is de-energized or control power fuses are blown. Correct as indicated. 2. Damage to wiring, terminals or connectors. Check and repair as necessary. 3. No tripping signal to multi-pin plug contact C2. Check for continuity and correct protective relay logic. 4. Secondary multi-pin plug contacts C2 or D2 are not engaging. Check and replace if required. 5. Failure of trip coil (52T). Check and replace if necessary. 6. Auxiliary switch 52a NO contacts 23 to 24 or 33 to 34 are open when circuit breaker is closed. Check linkage and switch. Replace or adjust as necessary.
	Tripping coil (52T) energizes. No tripping sound is heard, and circuit breaker contacts do not open. In other words, they remain closed.		1. Failure of tripping spring or its mechanical linkage. Check and replace if required.
	Tripping coil (52T) energizes. Tripping sound is heard, but circuit breaker contacts do not open.		1. Mechanical failure of operating mechanism. Check and contact the factory or Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S. 2. One or more of the vacuum interrupters are held closed. Check and replace as necessary.
Nuisance or false trip	Electrical problem		1. Tripping signal remains energized on secondary multi-pin plug contact C2. 2. Check for improper protective relay logic.
	Mechanical problem		1. Mechanical failure of operating mechanism. Check and contact the factory or Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.

Overhaul

⚠ WARNING

Hazardous voltages and high-speed moving parts.

Can cause death, serious injury, or property damage.

All replacement of circuit breaker components must be performed with the circuit breaker completely de-energized and the springs discharged.

Type	Number of closing operations
SDV-R	10,000
SDV-R-AR	

Table 6: Overhaul schedule ANSI/ IEEE "usual conditions"

Circuit breaker overhaul
Table 6 lists the recommended overhaul schedule for type SDV-R distribution circuit breakers operating under ANSI/IEEE “usual service conditions” as discussed in ANSI/IEEE C37.04 and elaborated in C37.010. When actual operation conditions are more severe or the circuit breaker operated more frequently, overhaul period may coincide with the maintenance interval in Table 3: Maintenance and lubrication intervals on page 36. The operations counter on the front panel of the circuit breaker records the number of operations.

Replacement at overhaul
The following components are replaced during an overhaul of the circuit breaker, when required:

- Vacuum interrupters as determined by vacuum integrity test, contact erosion or according to overhaul schedule (refer to Table 6)
- Close coil, 52SRC
- Trip coil, 52T.

When these parts are changed, locking devices must also be removed and replaced. These include lock washers, retaining rings, retaining clips, spring pins, cotter pins, etc.

1. Vacuum interrupters must be replaced by factory-trained personnel. Contact Siemens medium-voltage customer service at +1 (800) 347-6659 or +1 (919) 365-2200 outside the U.S.
2. Close coil (52SRC) and trip coil (52T).
   - Remove two “push on” terminal connections
   - Remove two M4 hex-head screws and remove solenoid.
   - Install replacement coils with new M4 x 10 hex-head screws (Siemens part # 00-000-443-820) and new lock washers for M4 (Siemens part # 00-000-288-316).
   - The coil-mounting screws must be installed using thread locking adhesive (Loctite #222, Siemens part 15-133-281-007) and primer (Loctite primer T (#7471), Siemens part 15-133-281-005).
   - Connect wires to coils with new wire terminals (Siemens part # 15-171-600-002).
3. Lubricate operating mechanism according to maintenance and lubrication information in the maintenance section of this manual.
4. When work is complete, operate the circuit breaker and close and open several times, and check that all screw connections are tight.

Hydraulic shock absorber

The mechanism is equipped with a hydraulic shock-absorber that functions when the circuit breaker opens. The shock absorber should require no adjustment. However, at maintenance checks, the shock absorber should be examined for evidence of leaking. If evidence of fluid leakage is found, the shock absorber must be replaced to prevent damage to the vacuum interrupter bellows.

After and internal arcing fault

In the unlikely event of an internal arcing fault, de-energize and isolate all primary and secondary circuits before performing any inspections. Contact Siemens medium-voltage customer service at +1 (800) 347-6659 or +1 (919) 365-2200 outside the U.S for assistance with repairs or replacement parts and components.

Disposal

⚠ WARNING

Stored energy.

Can cause death, serious injury, or property damage.

Mechanisms contain stored energy, which may be released during disassembly.

Wear suitable protection and take appropriate precautions when disconnecting and removing moving parts.

⚠ WARNING

Heavy objects.

Can cause death or serious injury.

Disassembly may cause an unbalanced load, and could result in falling objects.

Take appropriate precautions in a properly designated workspace to maximize support and stability.

Siemens equipment is environmentally friendly product predominantly consisting of recyclable materials. For disposal, some disassembly, separation, and professional services handling may be required.

Materials to be handled include but are not limited to:

- Metals: Should be transferred and recycled as mixed scrap metals.
- Plastics: Plastic containing a recycle symbol should be recycled. Plastic lacking the recycle symbol should be discarded as industrial waste.
- Small electronics, insulated cables, and motors: Should be recycled via electronics scrap disposal companies specialized in separating and sorting as described above.
- Batteries: Should be recycled via a recycling company.

Disposal regulations vary from locality to locality and may be modified over time. Specific regulations and guidelines should be verified at the time of waste processing to ensure that current requirements are being fulfilled. For specific assistance in understanding and applying regional regulations and policies or manufacturer's recommendations, refer to the local Siemens service representative for additional information.

Appendix

Table 7: Technical ratings

Circuit breaker type	Rated maximum voltage	Rated withstand voltages		Rated short-circuit and short-time current	Rated interrupting time[1]	Rated continuous current	Rated transient recovery voltage[2]		Rated permissible tripping delay time Y	Rated closing and latching current
		Lightning impulse (BIL)	Power frequency				u_c TRV peak value	t_3 time to voltage u_c		
	kV, rms	kV[3]	kV	kA, rms	ms/cycles	A, rms	kV	μs	sec	kA, peak
38.0-25	38.0	200/258	80	25	50/3	1,200, 2,000	71.7	59	2	65
38.0-31.5	38.0	200/258	80	31.5	50/3	1,200, 2,000	71.7	59	2	82
38.0-40	38.0	200/258	80	40	50/3	1,200, 2,000	71.7	59	2	104

Addtional key ratings for SDV-R and SDV-R-AR:
- Rated closing time <45 ms
- Rated opening time <30 ms
- Rated mechanical switching time (vacuum circuit breaker open to ground switch close) 12-16 ms
- Grounding switch rated short-time current 12.5 kA
- Grounding switch rated closing and latching current 32.5 kA.

Addtional key ratings for SDV-R-AR:
- Rated accessibility type 2B
- Rated internal arcing short-circuit current 25, 31.5, or 40 kA
- Rated arcing duration 0.5 s.

Footnotes:
1. TRV values are in accordance with ANSI/IEEE C37.04-2018
2. First value is full-wave impulse withstand circuit breaker open or closed. Second value is chopped-wave impulse withstand, applicable only with circuit breaker closed.

Table 8: Control data

Stored-energy operator						
	Range		Close coil	Trip coil[1, 6]	Spring charging motor	
Nominal	Close	Trip	A	A	Amperes run (avg.)	Charging seconds
125 Vdc	90-140	70-140	2.1	7.4/4.8	4	10
250 Vdc	180-280	140-280	2.1	9.6/4.2	2	10
120 Vac	104-127	104-127	2.0	—	6	10
240 Vac	208-254	208-254	2.0	—	3	10

Footnotes:
1. First value is for standard 50 ms/three-cycle interrupting time. Second value is for optional 83 ms/five-cycle interrupting time
2. For stored-energy operator, power requirement for second trip coil is approximately 70 W (dc) or 50 VA (ac). Power requirement for undervoltage device is approximately 20 W (dc) or 20 VA (ac).

Table 9: Interrupting capacity auxiliary switch contacts

Type auxiliary switch	Continuous current A	Control circuit voltage			
		120 Vac	240 Vac	125 Vdc	250 Vdc
Circuit breaker auxiliary switch	10	Non-inductive circuit interrupting capacity in A			
		10	5	9.6	4.8
		Inductive circuit interrupting capacity in A			
		6	3	6	3

Table 10: Type SDV-R distribution circuit breaker weight in lbs (kg)

Voltage	Interrupting	Continuous current			
		1,200 A[1,2]	2,000 A[1,2]	Pallet	Seismic cross braces
38.0 kV	25/31.5/40 kA	5,030 (2,282)	5,525 (2,506)	150 (68)	177 (77)

Footnotes:
1. Weight does not include shipping pallet.
2. Weight does not include seismic cross braces.
3. Weights are for SDV-R non-arc-resistant versions. For SDV-R-AR arc-resistant versions, add 550 lbs (249 kg).

Table 11: Space heater data

Location	Heater wattage
High-voltage compartment	1,200[1]
Relay and control compartment	100[1]
Operator compartment - stored-energy operator (for application below -30 °C down to -50 °C)	150[2]

Footnotes:
1. Thermostat controlled and set to turn off at 95 °F.
2. Thermostat controlled and set to turn off at 10 °F.

Table 12: Technical ratings

Item	Unit	38.0 kV
Lightning impulse withstand voltage • Full wave 1.2/50 µs • Chopped wave 2 µs[1] • Chopped wave 3 µs	kV	200 258 ----
Power-frequency withstand voltage	kV	80
Rated short-circuit current	kA	25/31.5/40
%dc component	%	48
Rated closing and latching current	kA peak	65/82/104
Rated duty cycle • Reclosing duty • Non-reclosing duty	----	O-0.3 s-CO-15 s-CO
Minimum reclosing time[2]	s	0.3
Rated power frequency	Hz	60
Capacitance switching • Overhead line	A	100
Phase spacing (bushing center-to-center)	inches (mm)	19.5 (495)
External creep	inches (mm)	41.0 (1,040)
External strike-to-ground	inches (mm)	17 (480)
Operating temperature range[3] • Standard • Optional	°C	-30 to +40 -40 to +40[3]
Operating mechanism	----	Stored-energy
Closing time	ms	55
Opening time by interrupting time • Three-cycle • Five-cycle	ms	≤38 ≤56
Dual trip coils (mechanically and electrically independent)	----	Optional
Auxiliary voltages (options) • Close, trip and protection • Space heaters, auxiliaries	---- Vac	See Table 8 120/240
Contact gap (stroke) Vacuum interrupter type 1,200 A 2,000 A	mm	18-22 18-22

Footnotes:

[1] Circuit breaker is in closed position.

[2] User must supply external time delay (typically using setting in reclosing relay) for the minimum reclose time interval of 0.3 s in accordance with ANSI/IEEE.

[3] Consult factory for -50 °C.

Published by Siemens Industry, Inc. 2020.

Siemens Industry, Inc.
7000 Siemens Road
Wendell, North Carolina 27591

For more information, For more information, including service or parts,
please contact our Customer Support Center.
Phone: +1 (800) 333-7421

To request a service or parts quote online, visit:
www.usa.siemens.com/techsupport or
e-mail callcenter.industry@siemens.com.

www.usa.siemens.com/sdv

Article No. SIDS-T40038-00-4AUS

Printed in U.S.A.